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STATE DOCUMENTS

ECONOMIC ANALYSIS
OF
INTERSTATE HIGHWAY ROUTINGS

FROM
BILLINGS
TO
TOLUCA
VICINITY

PREPARED BY

PLANNING SURVEY DIVISION

AND

INTERSTATE DIVISION

OF

MONTANA STATE HIGHWAY COMMISSION

IN COOPERATION WITH

U. S. DEPARTMENT OF COMMERCE

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ECONOMIC ANALYSIS OF INTERSTATE HIGHWAY ROUTINGS--BILLINGS TO TOLUCA VICINITY

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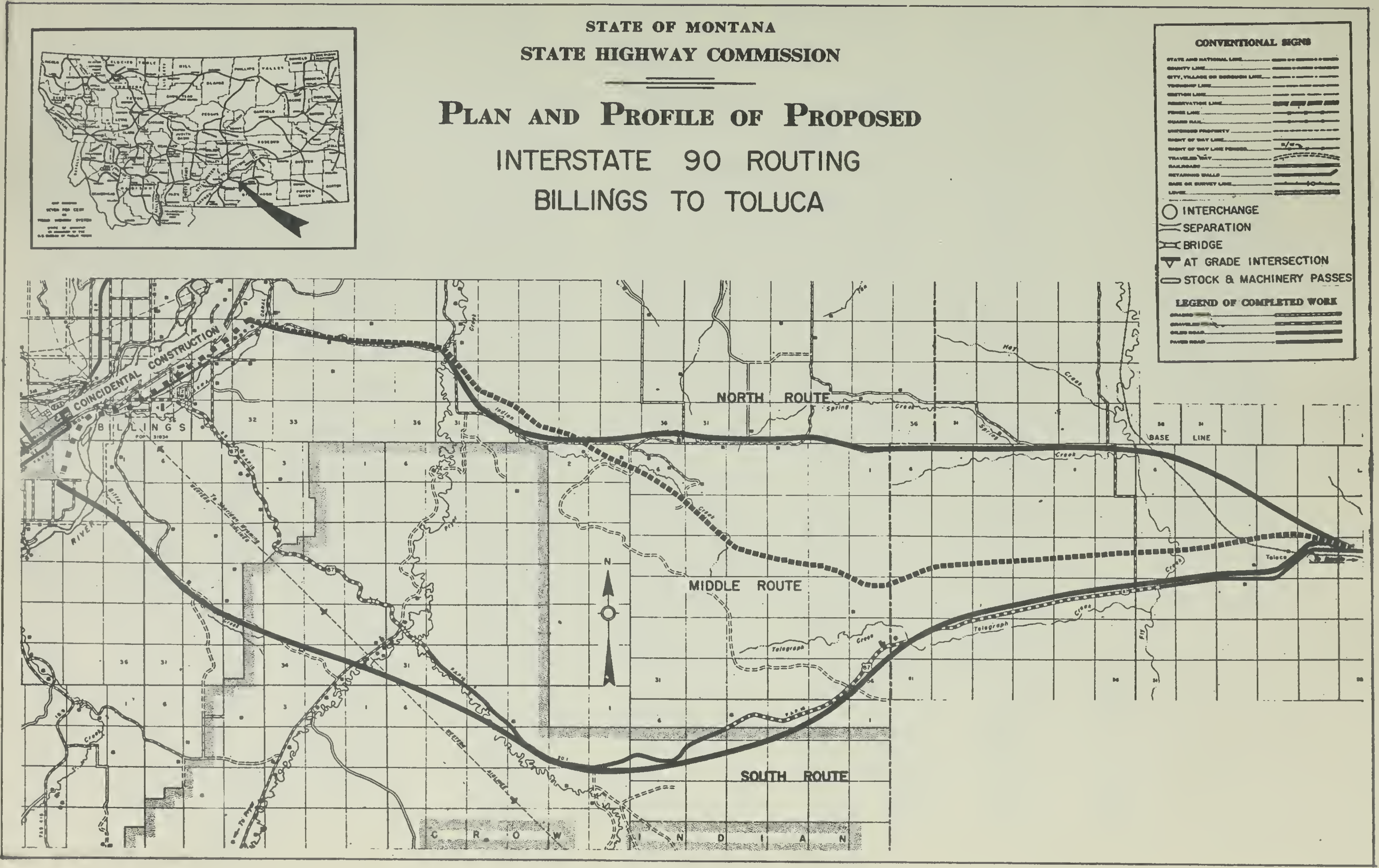
STATE OF MONTANA

STATE HIGHWAY COMMISSION

PLAN AND PROFILE OF PROPOSED

INTERSTATE 90 ROUTING
BILLINGS TO TOLUCA



ECONOMIC ANALYSIS OF ALTERNATE LOCATIONS
FOR INTERSTATE ROUTE NO. 90
FROM A POINT NEAR BILLINGS TO A
POINT NEAR TOLUCA WEST OF HARDIN

March 15, 1961

FOREWORD

This analysis has been prepared to compare the relative merits of three alternate locations for Interstate Route No. 90 from a point near Billings to a point near Toluca. Toluca is a railroad control point about 11 miles west of Hardin where present U.S. # 87 crosses the C.B. &. Q. R.R. tracks.

There are many and varied interest which are affected by the location of a new highway. These interests may be classified into three broad categories of the land owner who may be required to relinquish a portion of his land or buildings for right-of-way purposes, the commercial establishment owner or operator who depends on highway traffic for his livelihood, and the highway user who pays for the cost of constructing and maintaining the highway and also the cost of operating his vehicle on the highway.

In urban areas or highly developed rural areas, the location of a new highway is of great concern to owners of land or residential property which might be needed for highway rights-of-way. In the case of the three routes which are under consideration in this analysis, the land and property damages are not of great importance and there is only a minor degree of difference in damages among the three routes since they are located predominantly through relatively undeveloped land.

An exception to this statement applies to the section of highway between Control Points N1 and N2 as shown the enclosed area map. This section of highway traverses some well developed land east of Billings; however, the damage is not an issue in this report for the reason that an east-west Interstate highway will be located through this area regardless of the specific location selected for Interstate Route No. 90 between Billings and Toluca.

For example, if Interstate Route 90 were to follow the location shown as the South Route on the enclosed area map, it would not affect the property shown between Control Points N1 and N2; however, it would still be necessary to construct Interstate Route 94 along the line between Control Points N1 and N2. Section N1 to N2 would be part of Interstate 90 for the North and Middle routes and it would be part of Interstate 94 if the South Route were to be constructed.

Therefore, Section N1 to N2 is not an issue insofar as property damage or construction and maintenance costs are involved in comparing the three alternate locations for Interstate Route 90.

It also appears that none of the alternate locations for Interstate Route 90 would have an appreciable effect on present service establishments such as motels, service stations and eating places.

It is true that there are a few service establishments in the area to the east of Billings which derive some patronage from highway traffic on present

U. S. # 87, and if the South Route were to be selected, this traffic would no longer pass through this area. Conversely, however, the North and Middle Routes would be of little benefit to these establishments for the reason that the proposed interchange in this area would be located some distance away from the present highway and there is little possibility that the Interstate highway traffic would travel out of its way to visit these establishments.

For practical purposes, therefore, it may be assumed that the effect on land or other property and existing commercial establishments does not constitute a major consideration in the selection of the most favorable location for Interstate Route 90.

It is intended, therefore, that this analysis will be devoted to an appraisal of the merits of the alternate routes from the standpoint of the highway user.

The highway user is vitally interested in the selection of the most favorable highway location for the reason that the money for the construction and maintenance of the highway is derived almost entirely from taxes and other fees which are paid by the highway user to the Federal Highway Trust Fund and the State Highway Fund. It naturally is to the advantage of the highway user that this money be expended in the most economical manner.

The highway user also must pay the cost of operating his vehicle on the highway. In most cases, the cost of vehicle operation amounts to about 4 times the cost of constructing and maintaining the highway system, and for this reason, traffic service has an important bearing on the selection of the most favorable location for a new highway.

It is possible that the highway location having the lowest cost for construction and maintenance would involve excessive vehicle operating costs to the extent that it would be the least favorable route to the highway user from an overall standpoint. For this reason, it is necessary to give consideration to all three costs - construction, maintenance and vehicle operation - in determining the most favorable location.

The following pages are devoted to a description of each route and a review of the construction, maintenance and vehicle operating costs involved for each route. These costs are then summarized for a comparison of the composite rating for each route.

ROUTE DESCRIPTIONS

The locations of the different routes are shown on the enclosed map of the area between Billings and Toluca. Detailed photography and profiles for each route are also shown on the enclosed aerial photography.

For convenient reference, these routes are identified in relation to their general geographic location as the NORTH ROUTE, MIDDLE ROUTE and SOUTH ROUTE. As may be noted on the area map, the North Route and the Middle Route follow the

same line between Control Points N1 and N3. Beyond Control Point N3, each route follows a separate line and has separate identifying control points.

NORTH ROUTE

The North Route begins at Control Point N1-S1 which is the common western terminus for all three routes. This terminus is the proposed interchange which is located on the extension of South 27th Street, at the southeast edge of the city limits of Billings.

After leaving this interchange, the North Route follows along the north edge of the Yellowstone River and crosses the river at a bridge site about one-quarter mile upstream from the present bridge for U. S. # 87. The route then extends through the developed area known locally as Lockwood Flats. This is an area of mixed residential, commercial and industrial development. A large oil refinery is located in this vicinity, and it is the source of considerable traffic generation. At Control Point N2, the North Route has an interchange serving the intersection of Interstate Route 90 and 94. Route 94 begins at this point and extends along the Yellowstone River to Huntley and then continues eastward along the general location of present U. S. # 10 to Wibaux and the North Dakota State line.

After leaving Control Point N2, near the Pinehills Subdivision, the North Route extends up a small gulch to the top of a bench. Substantial grades are involved in the transition from the valley floor to the bench. The route then crosses the bench to a point about 1.5 miles west of Control Point N3 where the route then descends from the bench to the valley of Pryor Creek. Substantial grades are also involved in the descent to the valley floor.

At Control Point N3, the North Route intersects with a local road leading to the community of Huntley. An interchange is proposed at the site of this intersection. After leaving Control Point N3, the North Route follows along the general alignment of a local road on Indian Creek, a tributary to Pryor Creek. In the vicinity of Control Point N4, the route climbs again to benchland, and in the vicinity of a rural schoolhouse, the route interchanges with another local road. Beyond this interchange, the route follows along the base township line to a point of intersection with a local road extending northward to Ballantyne. At-grade connections will be permitted at this intersection.

Eastward from the Ballantyne Road, the route crosses a track of the Chicago, Burlington and Quincy Railroad and continues for about 6 miles to the common eastern terminus for all routes at the connection with present U. S. # 87 near Toluca. This is identified as Control Point N6-M4-S3.

From Control Point N2 to Control Point N6, the North Route is predominantly in grazing land. Some dry-land grain farming takes place on the benchland. A small amount of irrigated land is encountered along Pryor and Indian creeks.

The construction length of the North Route between Control Points N2 and N6 is 28.9 miles. About 4.9 miles of four-lane highway is required between Control Points N2 and N3 because of the adverse grades involved in the ascent to and descent from the benchland separating these control points.

MIDDLE ROUTE

The Middle Route follows the same line as the North Route from Control Point N1 at Billings to Control Point N3 at Pryor Creek. From this point, the Middle Route follows along the northeastern edge of Indian Creek valley for a distance of about 4 miles where it crosses the existing county road and then follows on new location up Indian Creek to its headwaters.

It then crosses a low divide in this vicinity and continues along rolling benchland to a point about 1.5 miles north of present U. S. # 87 and near the Yellowstone-Big Horn County line. From this point to the common eastern terminus, it follows a line approximately parallel to U. S. # 87 and about one mile north of this highway.

This route is also predominantly in grazing land; however, some irrigated land is involved in the vicinity of Pryor Creek and Indian Creek. There is also some grain farming in the vicinity of Toluca.

The Middle Route is 29.0 miles long between Control Points M2 and M4. It also involves the same 4.9 miles of four-lane construction as reported for the North Route between Control Points N2 and N3.

SOUTH ROUTE

The South Route begins at the common terminus with the other routes at the southeast edge of Billings. Approximately one mile southeast of Billings, the South Route crosses the Yellowstone River. A major structure must be constructed at this point on a somewhat unfavorable site. After the river is crossed, the route follows up Bitter Creek on a new location. Although there is an existing low-standard road in this drainage course there would be little or no salvage value for this road, and the Interstate highway would follow a new line. The route continues to the headwaters of Bitter Creek, crosses a low divide, and then descends into the upper Pryor Creek valley. The grades over this divide are not restrictive with the exception of short 4% grades in the vicinity of the Yellowstone River and Pryor Creek.

In crossing the Pryor Creek valley, the route will traverse a small amount of irrigated land. On the east side of the Pryor Creek valley, the route crosses a small ridge and then continues to a connection with present U. S. # 87 about 4 miles east of Pryor Creek.

From this point, the Interstate highway follows quite closely the alignment of present U. S. # 87. It will overlay U. S. # 87 for about one mile but with this exception, it should be possible to keep the remainder of the

present highway open to serve local traffic as a frontage road. The route terminates at the same common terminus near Toluca.

Between the interchange south of Billings and the Yellowstone River, the South Route crosses some well developed farm land and will involve the removal or destruction of a few residences and other buildings. In the vicinity of Pryor Creek and Telegraph Creek, the route will cross some irrigated land. For the remainder of the route the land is devoted mostly to grazing.

The South Route has a construction length of 34.8 miles. It is expected that two-lane construction will suffice throughout the route since there is no adverse terrain which will require four-lane construction to meet visibility and passing standards, as is the case with the North and Middle Routes.

About 15 miles of the South Route is located within the boundaries of the Crow Indian Reservation. In any case where this route crosses land under Indian ownership, the construction cost may be paid with 100% Federal funds thereby eliminating the need of State matching funds at the prevailing ratio of 8.76%.

CONSTRUCTION FEATURES

The following table shows a comparison of the construction features for each of the alternate routes;

TABLE NO. 1

	NORTH ROUTE	MIDDLE ROUTE	SOUTH ROUTE
Construction length in miles	28.9	29.0	34.8
Overall travel distance from Billings to Toluca	35.2	35.3	34.8
Miles of 4 lane construction	4.9	4.9	- -
Number of interchanges	3	2	2
Number of Highway separations	3	4	- -
Number of railroad separations	1	1	1
Number of bridges	2	2	3
Miles of new frontage road	11.3	4.8	1.2
Number of grades over 3%	8	6	5
Total rise and fall in feet	2,675	2,605	2,425
Maximum elevation	3,925	3,900	3,775

Interchanges for the North Route are located at the Pinehills Subdivision, the Pryor Creek Road, and the Base Line Road. Interchanges for the Middle Route are located at the Pinehills Subdivision and the Pryor Creek Road. The South Route interchanges are located at South 27th Street and the Pryor Creek Road.

Highway separations for the North Route are located at two places crossing the local road between the Pinehills Subdivision and the Pryor Creek Road. There is also another highway separation over the Pryor Creek Road.

Highway separations on the Middle Route are located at approximately the same sites as the North Route with the exception that another separation is located where the Interstate highway crosses the Indian Creek Road.

No highway separations are involved on the South Route.

Railroad separations are required for all routes where the individual routes cross the C. B. & Q. R. R.

Bridges for all routes are required for crossings of Pryor Creek and Fly Creek. In addition, a major structure is required where the South Route crosses the Yellowstone River.

DESIGN CRITERIA

Typical Sections

For the purpose of this report two sections were used. A 46 foot depressed median was used in the four-lane sections. The two-lane section was the standard for all interstate projects. Both sections use a 0.35' plant mix surface on the travel lanes, with a 0.15' cushion, and 1.33' of base surfacing as recommended by a field review.

Interchanges

The interchange at South 27th Street in Billings is a diamond-type for the North route and the Middle Route. The interchange at this location for the South Route is the junction of two freeways and must also provide local access; for these reasons, the more elaborate cloverleaf-type interchange is required.

The junction of the two interstate routes on the North Route and the Middle Route is a trumpet-type interchange located near the Pinehill Subdivision. No local access is permitted on this interchange.

All other interchanges in this study are of the diamond-type.

Standards

The Geometric Design Standards for the National System of Interstate and

Defense Highways, the American Association of State Highway Officials Policy on Geometric Design of Rural Highways, and the Montana Highway Commission's Field and Office Standards were used as design standards in this study.

ESTIMATING PROCEDURE

Grading Quantities

The North Route originally was the route chosen for inclusion in both the 108(d) and the 104(b) Estimates, submitted to Congress in 1957 and 1960 respectively. This route was prepared in 1957 on 1" to 200' aerial maps with a 4' contour interval. From these maps, cross-sections were taken at appropriate intervals and grades and typical sections were entered in the IBM 650 electronic computer to obtain the earthwork quantities.

The Middle Route was investigated in an attempt to improve on the North Route. The field investigation consisted of running alternate lines in this area using aerial photographs for horizontal control and a precision altimeter for the vertical control. Profiles were prepared and earthwork quantities were computed from curves which relate height of fill or depth of cut and cross-section elements to earthwork volumes. On the basis of these cut and fill quantities, the least favorable alternate lines were eliminated from further consideration in this study. The "best line" was then used as the Middle Route.

The South Route was developed in the same manner as the Middle Route. When it became evident that the costs of the North and South Routes were nearly equal, a more complete field reconnaissance was requested. This investigation took the form of a more detailed stadia survey on the alignment determined to be the most favorable in this area.

Drainage

The cost of drainage structures 72" in diameter and under was based on average cost per mile. This base was determined from the quantity and cost of pipe installed on an "average mile" constructed in 1959. The cost of culverts over 72" in diameter and the cost of stockpasses were estimated individually.

Surfacing

Surfacing quantities and prices are based on average cost per mile for similar design sections that were contracted in 1959.

Separations & Bridges

The estimated cost of railroad and highway separations and bridges was based on average unit prices per square foot of deck area. The cost estimate of the Yellowstone River Bridge on the South Route was made by the Bridge Division.

Interchanges

Studies were made to determine the interchange type and general geometrics, then costs were estimated from typical interchange designs. Interchange structure costs were estimated by the deck-area method. The costs of guardrail, curbs, signing and traffic control devices are included in the cost of the interchanges.

Guardrail, Fencing, & Signing

Guardrail was designed for use on all fills with a 2:1 slope and on all structure approaches. Fencing and signing costs were estimated on an average cost-per-mile basis.

Right-of-Way

Right-of-way costs are based on a field appraisal by the Right-of-Way Division.

CONSTRUCTION COSTS

A series of tables toward the back of this report show the estimated construction costs for each of the alternate Interstate highway locations. The costs are segregated by control sections and by principal cost categories.

The total construction costs shown present a comparison of the overall construction cost involved for each route. A better comparison is obtained, however, by reducing the total costs shown to an annual cost basis. The annual cost basis is preferable for comparison purposes for the reason that different cost items have different estimated service lives; consequently, the annual cost of the different items presents a better basis of comparison.

The enclosed Table No. 2 shows the total cost for each construction category for each route, the estimated service life, and the respective annual costs.

From this table, it may be observed that the North Route has the lowest overall construction cost and also the lowest annual construction cost. The overall construction cost for the North Route is $508,000, or 7%, lower than that for the Middle Route. The annual construction cost for the North Route is $14,915,or 6%, lower than that for the Middle Route.

In comparison with the South Route, the North Route has an overall construction cost of $936,000, or 12%, under the South Route and an annual construction cost of $20,985, or 9%, under the South Route.

From the standpoint of construction costs, the North Route would be the most favorable location for the Interstate highway.

MAINTENANCE COSTS

The following Table No. 3 shows the estimated annual cost of maintaining

TABLE No. 2

COMPARISON OF TOTAL AND ANNUAL CONSTRUCTION COSTS

COST CATEGORY	ESTIMATED SERVICE LIFE	NORTH ROUTE		MIDDLE ROUTE		SOUTH ROUTE	
		TOTAL COST	ANNUAL COST	TOTAL COST	ANNUAL COST	TOTAL COST	ANNUAL COST
Grade, drain, stockpasses	40 years	$2,589,000	$ 64,725	$3,160,000	$ 79,000	$2,690,000	$ 67,250
Base & surfacing	20 years	1,835,000	91,750	1,781,000	89,050	1,853,000	92,650
Railroad separations	50 years	89,000	1,780	89,000	1,780	89,000	1,780
Highway separations	50 years	33,000	660	33,000	660	- - -	- - -
Interchanges	50 years	868,000	17,360	707,000	14,140	644,000	12,880
Bridges	50 years	115,000	2,300	114,000	2,280	971,000	19,420
Guardrail, fencing, signing	20 years	326,000	16,300	432,000	21,600	349,000	17,450
Subtotal - construction cost		5,855,000	194,875	6,316,000	208,510	6,596,000	211,430
Right-of-way	50 years	115,000	2,300	94,000	1,880	204,000	4,080
Engineering & Contingencies	40 years	867,000	21,675	935,000	23,375	973,000	24,325
TOTAL COST		$6,837,000	$218,850	$7,345,000	$233,765	$7,773,000	$239,835
AVERAGE SERVICE LIFE		31.24 years		31.42 years		32.40 years	

Remarks: Since the interchanges near the Pinehill Subdivision are required only if the North or Middle Routes are built, the full cost of these interchanges is charged against the respective routes. Regardless of the Interstate highway location chosen between Billings and Toluca, it will be necessary to construct an interchange at South 27th Street to provide access to the city; however, if the South Route is constructed, it will be necessary to provide a more elaborate interchange at South 27th Street, and the extra cost of this facility is charged against the South Route.

present roads under existing conditions and the estimated annual cost of maintenance with the modifications and additions that would result from the construction of each of the alternate Interstate routes.

TABLE NO. 3

COMPARISON OF MAINTENANCE COSTS

	MTCE. COST/ MILE	EXISTING CONDITIONS		NORTH ROUTE		MIDDLE ROUTE		SOUTH ROUTE	
		MILES	COST	MILES	COST	MILES	COST	MILES	COST
Local roads	$ 200	31.1	$ 6,220	25.6	$ 5,120	28.1	$ 5,620	31.1	$ 6,220
U. S. # 87	1,500	36.4	54,600						
U. S. # 87 1/	1,000			36.4	36,400	36.4	36,400		
U. S. # 87 2/	500							29.4	14,700
Interstate 2-lane	2,000	- -	- -	24.0	48,000	24.1	48,200	34.8	69,600
Interstate 4-lane	3,000	- -	- -	4.9	14,700	4.9	14,700	- -	- - -
Frontage Road	500	- -	- -	11.3	5,650	4.8	2,400	1.2	600
TOTALS		67.5	$60,820	102.2	$109,870	98.3	$107,320	96.5	$91,120

1/ If the North Route or the Middle Route were to be constructed, it would still be necessary to keep U. S. # 87 intact throughout its length to serve the local traffic which could not use the Interstate highway. Maintenance would be to a lower standard with a lower cost per mile.

2/ If the South Route were to be constructed, present U. S. # 87 would be converted to frontage road status from Toluca to Pryor Creek. From Pryor Creek to the edge of the Lockwood area, present U. S. # 87 passes through an undeveloped area and would not provide any essential traffic service. It is assumed that maintenance could be discontinued on this section of highway without serious detriment to traffic. With the remainder of U. S. # 87 being relegated to frontage road status, the maintenance cost should be substantially lower than the present cost of maintaining this highway.

The overall cost of maintenance under the South Route proposal would be $18,750 per year cheaper than the North Route and $16,200 per year cheaper than the Middle Route. It is evident, therefore, that the South Route would be the preferred location from the standpoint of maintenance costs.

TRAFFIC SERVICE

An important consideration in an analysis of this type is the appraisal of the effect on traffic of the alternate Interstate routings and the assignment of traffic to each route. The assignment of traffic to these routes has been made on the basis of information obtained from an origin-destination survey made in the vicinity of Billings, a special origin-destination survey made on U. S. # 87 south of the Lockwood flats and from figures developed through our regular traffic counting program on the main highways and local roads in this vicinity.

Traffic assignments have been made on the basis of the following premises:

1. It is assumed that all through trips would use the new Interstate highways in preference to existing U. S. #87 which is narrow and crooked and has substantial grades. The through trips include all trips between Billings and points beyond and Toluca and points beyond.

2. Trips of a local nature in the vicinity of Billings would have the same Interstate highway network in the immediate area, regardless of the final route selected. For this reason, trips of this type would not be affected by the Interstate highway routings beyond the immediate area.

3. There is a moderate volume of traffic of about 140 vehicles per day which have origins or destinations on the Pryor Creek road to the south of present U. S. # 87. The North and Middle Interstate routes would not be able to serve this type of traffic and the traffic would have to continue using present U. S. # 87 for travel into and out of this area.

   If the South Route were to be constructed, this traffic would have the advantage of being able to use the higher standard Interstate facilities for such travel.

4. There is a small amount of traffic,of about 25 vehicles per day,of local origin and movement on present U. S. # 87 between Pryor Creek and Toluca. If the South Route were to be constructed, this traffic would have the advantage of being able to use the Interstate facilities for a portion of the travel. The use of Interstate facilities would not be possible if the North or Middle routes were to be constructed.

5. There is a small amount of traffic, of about 25 vehicles per day, on the present county roads in the vicinity of the North and Middle routes. This traffic would gain an advantage in being able to use Interstate facilities for a part of the travel under the North and Middle route proposals. The South Route would be of no advantage to this type of traffic.

Table No. 4 shows a comparison of the amount of travel involved under present conditions with a distribution by system. The table also shows the amount of travel and the distribution by system under each of the alternate Interstate System routing proposals.

In computing the annual vehicle-miles of travel, the travel distances between various points of origin and points of destination were measured by this travel distance was multiplied by the number of trips between the points as derived from the traffic analysis. The consolidated results are shown in this table.

The table also shows the average trip length for each movement on the various systems. This average represents a weighted average of various trip lengths and is derived by dividing the annual vehicle-miles of travel by the number of trips per year.

The numbers of annual trips for each route are not directly comparable for the reason that one overall trip might be shown for one condition whereas the same trip might be split into two trips of shorter length under another condition . For example, a trip from west of Billings to Toluca under present conditions would be shown as one trip for 5.9 miles on city streets and a separate trip of 35.4 miles on the Primary-Rural System. Under the Interstate System routings, this would be shown as a single trip on the Interstate System.

From Table No. 4 it may be observed that the North Route would involve the least amount of overall travel. This routing would involve 8.43% less travel than present conditions, 0.31% less travel than the Middle Route and 0.28% less travel than the South Route.

The South Route would have the advantage, however, that about 92% of the total travel involved would be performed on the Interstate System with its improved facilities. Both the North and Middle routes would carry about 85% of the total travel on the Interstate System.

VEHICLE OPERATING COSTS

In order to arrive at the cost of vehicle operation under the alternate routing proposals, it is necessary to multiply the annual vehicle-miles of travel, as shown in Table No. 4, by the unit cost applicable to each system and each condition. The basic figures used for this purpose are shown in Table No. 5.

These costs are based on unit values recommended by the American Association of State Highway Officials with appropriate adjustments being made for conditions prevailing in Montana. As stated in the footnote to Table No. 5, there is a greater than usual amount of heavy single-unit trucks and combinations using the present highway between Billings and Toluca, and this condition has the effect of raising the average truck operating costs above normal for the state.

Table No. 6 shows the results of computed operating costs for each system under each of the alternate routing proposals and under present conditions. The unit cost per vehicle-mile shown in Table No. 6 represents a weighted average of passenger car and truck costs as derived by applying the basic costs for different sections of highway as shown in Table No. 5.

TABLE NO. 4

COMPARISON OF ANNUAL TRAVEL

	COUNTY ROADS	CITY STREETS	PRIMARY RURAL	INTERSTATE	ALL SYSTEMS
PRESENT CONDITIONS					
Annual Trips	43,800	573,050	573,050		1,189,900
Average trip length	6.80	3.22	30.92		16.70
Annual VM of travel	297,840	1,847,995	17,720,385		19,866,220
% of total travel	1.50	9.30	89.20		100.00
NORTH ROUTE					
Annual trips	20,075	465,375	134,685	487,275	1,107,410
Average trip length	6.91	2.58	10.42	31.70	16.43
Annual VM of travel	138,700	1,199,025	1,403,790	15,450,450	18,191,965
% of total travel	0.76	6.59	7.72	84.93	100.00
MIDDLE ROUTE					
Annual Trips	25,550	465,375	134,685	481,800	1,107,410
Average Trip length	8.17	2.58	10.42	32.04	16.48
Annual VM of travel	208,780	1,199,025	1,403,790	15,436,215	18,247,810
% of total travel	1.15	6.57	7.69	84.59	100.00
SOUTH ROUTE					
Annual trips	43,800	475,595	60,225	516,110	1,095,730
Average trip length	6.80	1.94	4.08	32.51	16.65
Annual VM of travel	297,840	920,895	246,010	16,778,685	18,243,430
% of total travel	1.63	5.05	1.35	91.97	100.00

TABLE NO. 5

BASIC OPERATING COSTS

	LANES	CONDITIONS	MPH	GRADES	COST PER VEHICLE-MILE PASSENGER	COST PER VEHICLE-MILE TRUCK
CITY STREETS						
Average of all streets	2	restricted	24	0-3%	$.1268	$.5143
PRIMARY RURAL						
Billings-Lockwood area	2	normal	32	0-3%	.1027	.4165
Lockwood-Pryor Creek	2	restricted	40	3-5%	.1163	.4717
Pryor Creek - Toluca	2	normal	56	0-3%	.1116	.4526
INTERSTATE						
NORTH and MIDDLE ROUTES						
West Billings-Lockwood area	4	free	48	0-3%	.0923	.3744
Lockwood area-Pinehill area	4	free	56	0-3%	.0939	.3809
Pinehill area-Pryor Creek area	4	free	56	3-5%	.0971	.3938
Pryor Creek area-Toluca area	2	free	60	0-3%	.1102	.4470
SOUTH ROUTE						
Billings area-Pryor Creek area	2	free	52	0-3%	.0960	.3894
Pryor Creek area-Toluca area	2	free	60	0-3%	.1102	.4470
COUNTY ROADS						
Average of all roads	2	unsurfaced	32	3-5%	.1395	.2093

NOTE; Operating cost of trucks are higher than normal because of the greater than usual amount of large single-unit trucks and combinations carried by the highway from Billings to Toluca. Trucks using county roads are of lighter weight and have lower operating costs.

TABLE NO. 6

COMPARISON OF ANNUAL OPERATING COSTS

	COUNTY ROADS	CITY STREETS	PRIMARY RURAL	INTERSTATE	ALL SYSTEMS
PRESENT CONDITIONS					
Annual VM of travel	297,840	1,847,995	17,720,385		19,866,220
Cost per VM	$.1481	$.1966	$.1800		$.1811
Total annual cost	$44,097	$363,317	$3,190,434		$3,597,848
NORTH ROUTE					
Annual VM of travel	138,700	1,199,025	1,403,790	15,450,450	18,191,965
Cost of VM	$.1478	$.1911	$.1753	$.1676	$.1696
Total annual cost	$20,495	$229,120	$246,071	$2,590,118	$3,085,804
MIDDLE ROUTE					
Annual VM of travel	208,780	1,199,025	1,403,790	15,436,215	18,247,810
Cost per VM	$.1482	$.1911	$.1753	$.1677	$.1696
Total annual cost	$30,933	$229,120	$246,071	$2,588,431	$3,094,555
SOUTH ROUTE					
Annual VM of travel	297,840	920,895	246,010	16,778,685	18,243,430
Cost per VM	$.1481	$.1869	$.1675	$.1692	$.1697
Total annual cost	$44,097	$172,070	$41,200	$2,838,888	$3,096,255

NOTE:

Operating costs for different routings vary because of different basic conditions and also because of different proportions of passenger cars and trucks.

From the figures shown in Table No. 6, it may be observed that all of the Interstate routing proposals will save the highway user about $500,000 per year as compared with present travel conditions. This amounts to annual savings of about 14%.

A comparison among the individual routes shows that the North Route has a slight advantage over the other routes; however, the margin of benefit amounts to less than one-third of one percent.

SUMMARY

As explained in the foreword, the final comparison of the alternate routes must take into consideration three different factors which are of interest to the highway user; namely, annual construction costs, annual maintenance costs and annual vehicle operating costs. The following summary table shows the values of these factors and the composite figures for each route:

	PRESENT CONDITIONS	NORTH ROUTE	MIDDLE ROUTE	SOUTH ROUTE
ANNUAL CONSTRUCTION COSTS		$ 218,850	$ 233,765	$ 239,835
ANNUAL MAINTENANCE COSTS	$ 60,820	109,870	107,320	91,120
SUBTOTAL	$ 60,820	328,720	341,085	330,955
ANNUAL OPERATING COSTS	3,597,848	3,085,804	3,094,555	3,096,255
TOTAL OF ALL COSTS	$3,658,668	$3,414,524	$3,435,640	$3,427,210
ANNUAL SAVINGS IN FAVOR OF NORTH ROUTE	$244,144	- - -	$21,116	$12,686
	(7.15%)		(0.62%)	(0.37%)

This table shows that the North Route has the lowest overall cost, being $244,144 per year less than present conditions, $21,116 per year lower than the Middle Route and $12,686 per year lower than the South Route. It may be noted however, that the margin in favor of the North Route is less than 1% when compared with the Middle Route or the South Route. An analysis of this type does not contain a degree of precision that would develop conclusive support for any route with a margin of 1% of savings on the basis of overall costs.

The benefit/cost ratio provides another means of comparing the relative merits of alternate highway routings. Under this procedure, each new route is compared with existing conditions in order to determine whether the benefits of reduced travel cost for the new routes exceed the extra costs of constructing and maintaining the new routes. The following shows the results of these computations:

$$\frac{\text{Benefits}}{\text{Costs}} - \frac{\text{Present Operating Costs - New Operation Costs}}{\text{New Const. \& Mtce. Costs - Existing Mtce. Costs}} - \text{Ratio}$$

$$\text{NORTH ROUTE} - \frac{\$3{,}597{,}848 - \$3{,}085{,}804}{\$\ 328{,}720 \quad \$\ \ 60{,}820} = \frac{\$512{,}044}{\$267{,}900} = 1.9113$$

$$\text{MIDDLE ROUTE} - \frac{\$3{,}597{,}848 - \$3{,}094{,}555}{\$\ 341{,}085 - \$\ \ 60{,}820} = \frac{\$503{,}293}{\$280{,}265} = 1.7958$$

$$\text{SOUTH ROUTE-} \quad \frac{\$3{,}597{,}848 - \$3{,}096{,}255}{\$\ 330{,}955 - \$\ \ 60{,}820} = \frac{\$501{,}593}{\$270{,}135} = 1.8568$$

Although it is not realistic to assume that it will be practical to maintain the present highway indefinitely, present conditions provide a suitable base with which to compare the new routes.

These ratios show that each additional $1.00 invested in construction and maintenance on the North Route will produce benefits equal to $1.91 in reduced operating costs. Similarly, each $1.00 of investment on the Middle Route will save $1.80 in operating costs and $1.00 of investment in the South Route will save $1.86 in operating costs.

It may be observed that these benefit/cost ratios favor the North Route; however, it should also be noted that the difference between the North Route and the South Route amounts to a margin of less than 3% in favor of the North Route. Such a margin is not considered to be sufficient to provide conclusive support for any route.

On the basis of the findings of this analysis, it appears that either the North Route or the South Route would qualify as the location for Interstate Route 90 south of Billings. The Middle Route would be somewhat less desirable.

There are other factors, however, which are not included in this analysis but which would have a bearing on the selection of the most favorable route.

In the computations to this point, it has been assumed that with the North and Middle routes it would be possible to keep the present highway between Lockwood Flats and Pryor Creek in serviceable condition through maintenance operations to serve the 140 vehicles per day on this highway that could not use the North and Middle routes.

In view of the fact that this highway was constructed in the early 1930's, there is some question that indefinite patching and resurfacing would be adequate to maintain a satisfactory highway. The alignment of the highway crossing the ridge between these points is substantially below present standards, and it would appear that reconstruction of this section of highway might become mandatory if the Interstate highway were to be located on the North or Middle routes.

It is estimated that reconstruction of this section of highway would cost about $100,000 per mile for a distance of about seven miles. This would make a total of $700,000 in construction costs which were not charged against the North

or Middle Route proposals. The amortization of this cost on a 30 year service life period would produce an annual construction cost of $23,333. By improving the highway, the operating costs for the 140 vehicles per day would be reduced below those estimated under continued maintenance status. The net reduction would be about $.0230 per vehicle mile of travel, or $8,242 per year. This $8,242 in reduced travel cost should be offset against the extra construction cost, making a net extra cost of $15,091 per year which should be charged against the North and Middle routes. This amount would place the South Route on an equal footing with the North Route in the comparison of total overall costs applying to each route.

Another feature favoring the South Route is the fact that both the North and Middle routes would not be able to serve through traffic to any extent until such time as they were completed throughout between the two termini at the Pinehills Subdivision and at Toluca and thereby connect with present U.S. #87. The South Route, on the other hand, would connect with the present highway in the vicinity of Pryor Creek. It is estimated that the Interstate construction on the South Route between Billings and the Pryor Creek area would be completed within three years. At this stage, the through traffic could use the new highway and connecting U.S. # 87 without having to wait for full completion of the Interstate highway to Toluca.

Since it is estimated that it would require about 6 years for full construction of any of the alternate Interstate routes, the South Route would have the advantage of three years advance usage of the section of highway between Billings and Pryor Creek. In monetary values this usage would be worth $410,561 per year in reduced operating costs, or $1,231,683 for the three year period. When spread over the 32.4 years of average life of the Interstate highway on the South Route, this amount of savings would equal $38,015 per year which was not included in the main analysis.

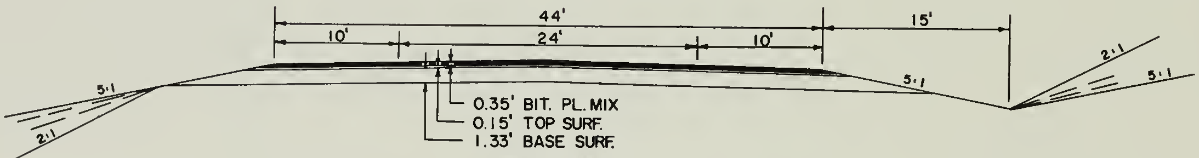
This amount would change the benefit cost ratio of the South Route to a revised figure of 1.9975 as compared with a ratio of 1.9113 for the North Route and 1.7958 for the Middle Route. With this adjustment, the South Route would be $25,329 per year less than the North Route and $46,445 per year less than the Middle Route from the standpoint of overall construction, maintenance and vehicle operating costs.

The South Route would be of greatest benefit to traffic with origins and destinations in Billings proper and the area to the west of Billings, including highways to the west of the city. The North and Middle routes would be of the greatest benefit to traffic with origins and destinations in the Lockwood Flats area and the area and highways to the east of Billings.

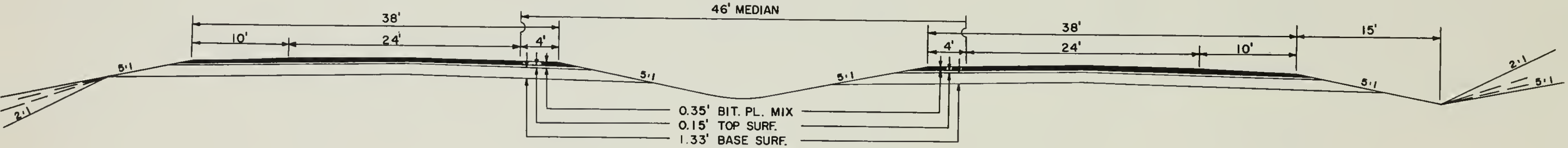
Although it is not possible to predict the extent of future development in this general area, it would appear that the current trend of greatest development in the western areas will continue for some time in the future. If so, this future development would have the effect of favoring the South Route as the location for Interstate Route 90.

On the basis of these additional features, it is considered that the South Route would be the most favorable location for Interstate Route 90 between Billings and Toluca.

TYPICAL SECTIONS



TWO LANE



FOUR LANE

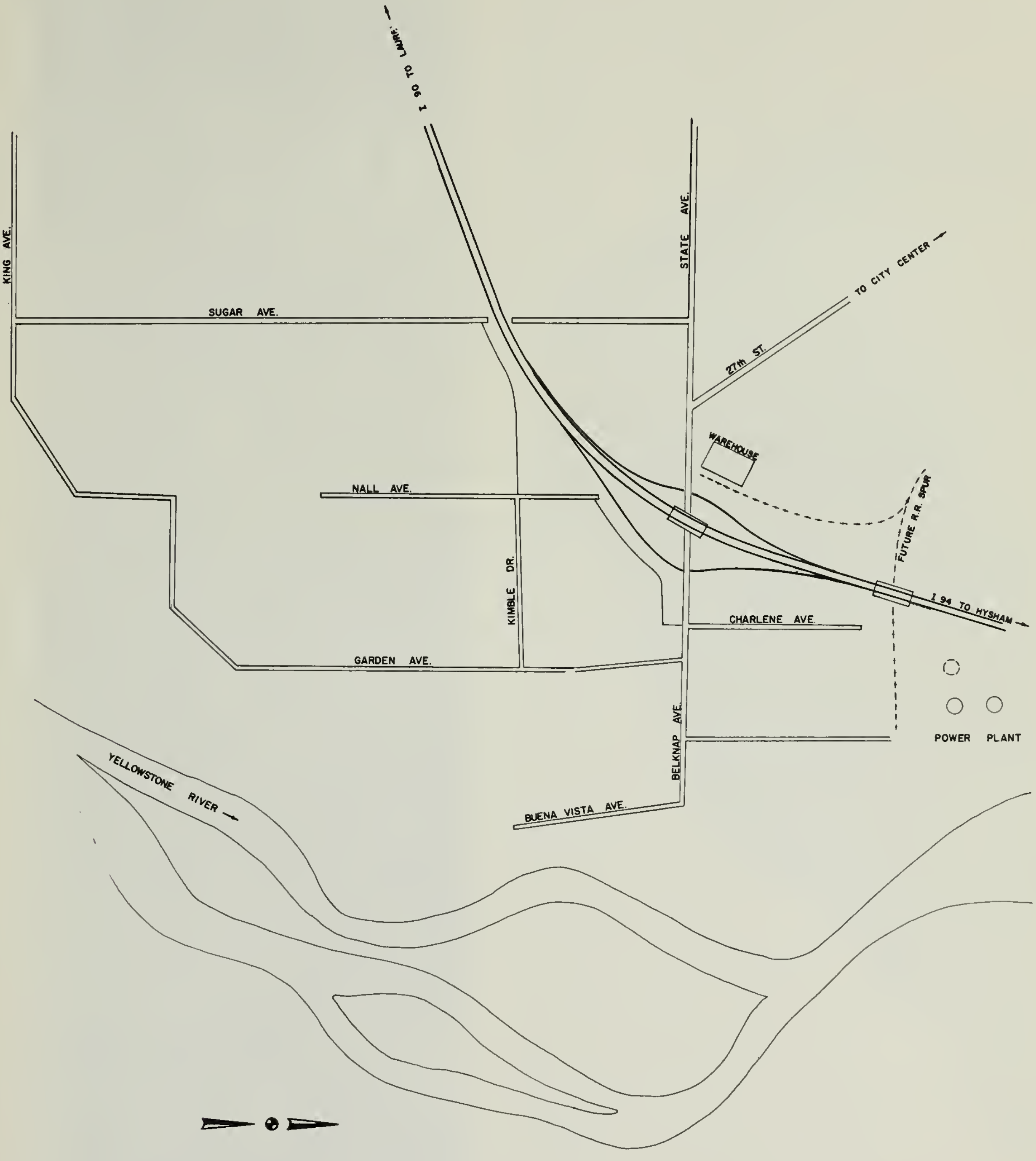
NORTH ROUTE COST ESTIMATE

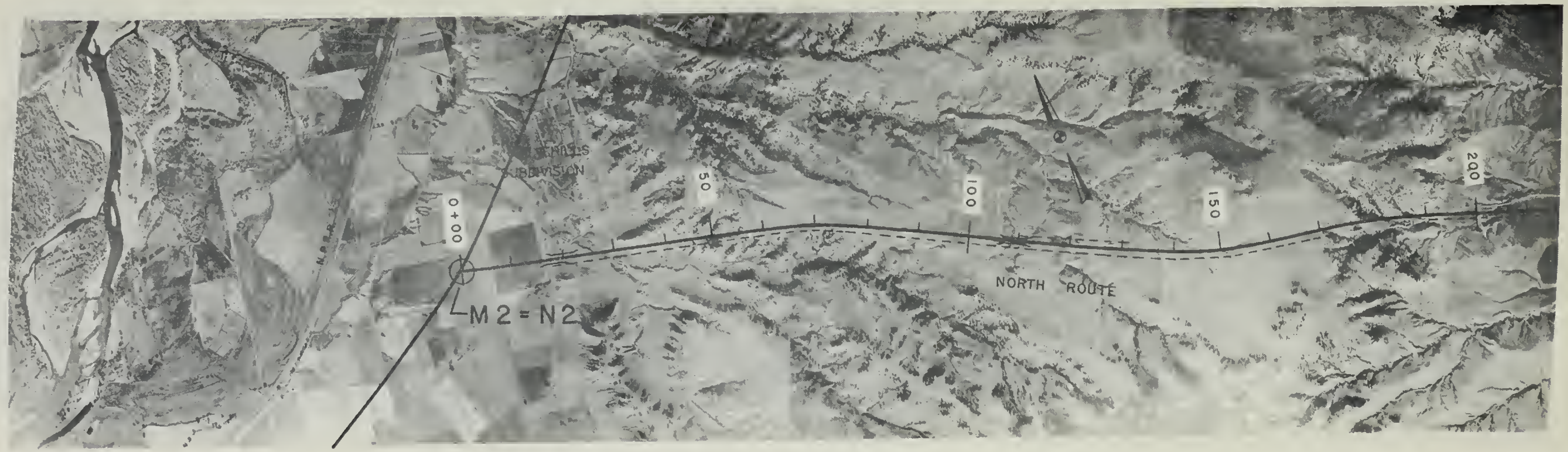
SECTION	N1-N2	N2-N3	N3-N4	N4-N5	N5-N6	TOTAL
LENGTH (MILES)		4.9	5.3	6.5	12.2	28.9
NUMBER OF LANES		4	2	2	2	
ITEMS		ESTIMATED COSTS ($1,000)				
GRADE, DRAIN, STOCK PASSES	*	1,557	199	448	385	2,589
BASE, SURFACING		498	296	386	655	1,835
RAILROAD SEPARATIONS					89	89
HIGHWAY SEPARATIONS			33			33
INTERCHANGES		504		159	205	868
BRIDGES		35	50		30	115
GUARDRAIL, FENCING, SIGNING		83	79	55	109	326
CONSTRUCTION COST		2,677	657	1,048	1,473	5,855
RIGHT OF WAY		63	29	13	10	115
ENGINEERING, CONTINGENCIES		397	98	155	217	867
TOTAL ESTIMATED COST		3,137	784	1,216	1,700	6,837

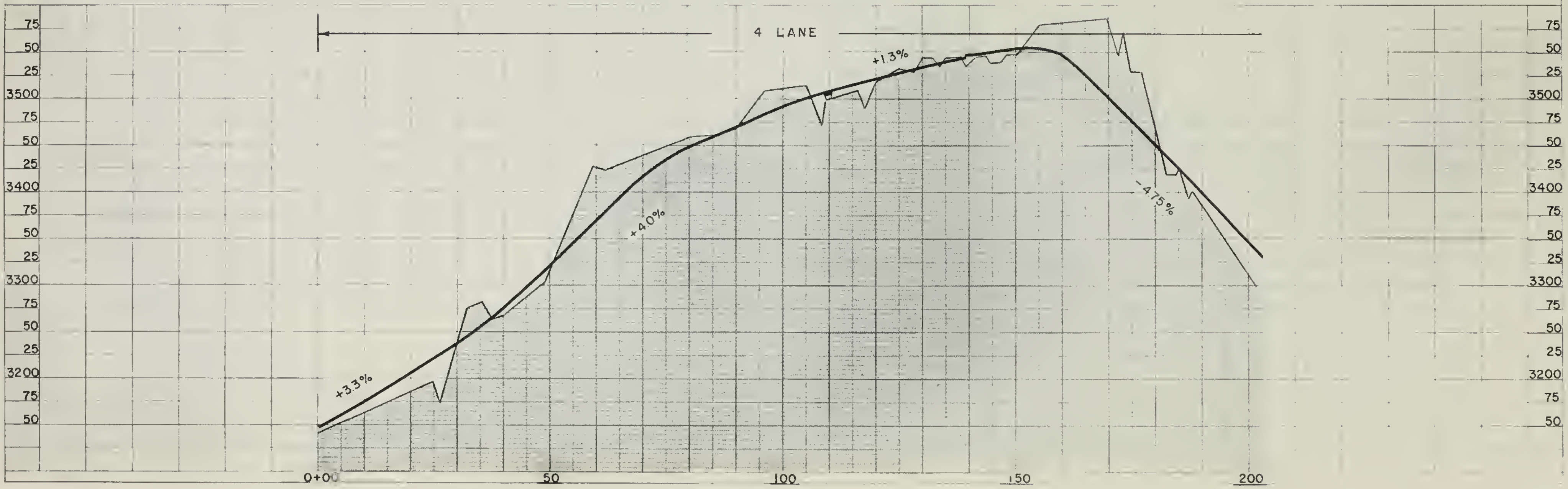
*Roadway construction is coincidental with I 94 and not included.

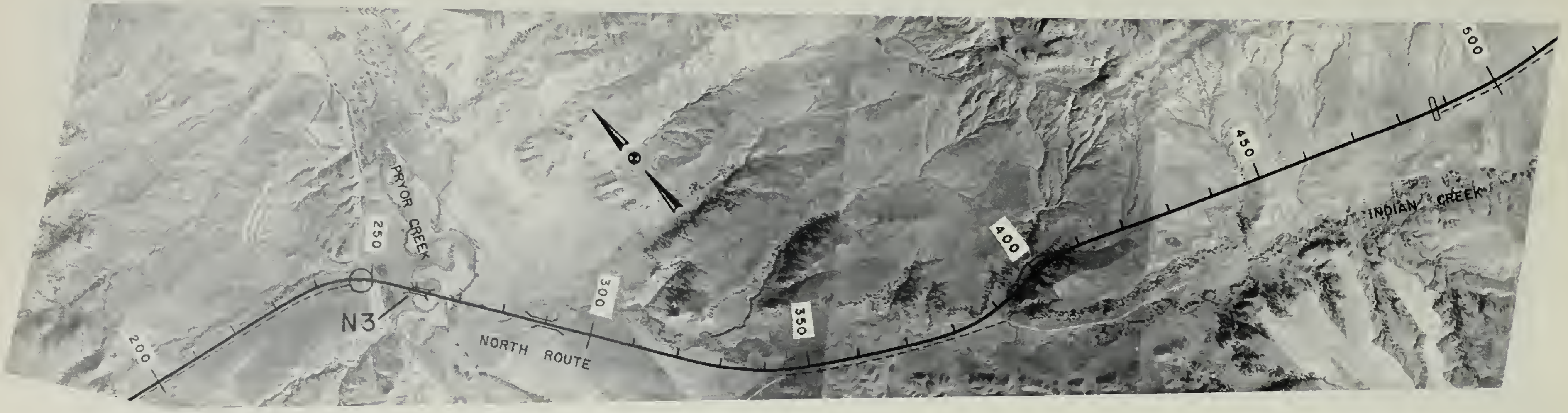
27TH ST. INTERCHANGE

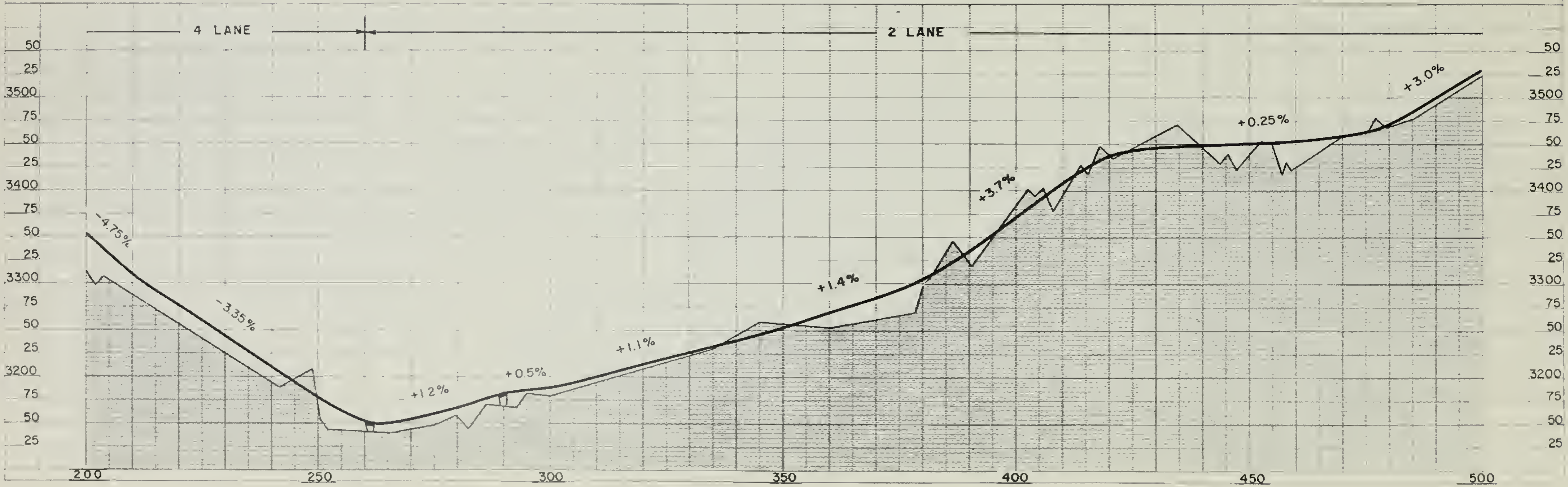
NORTH & MIDDLE ROUTES

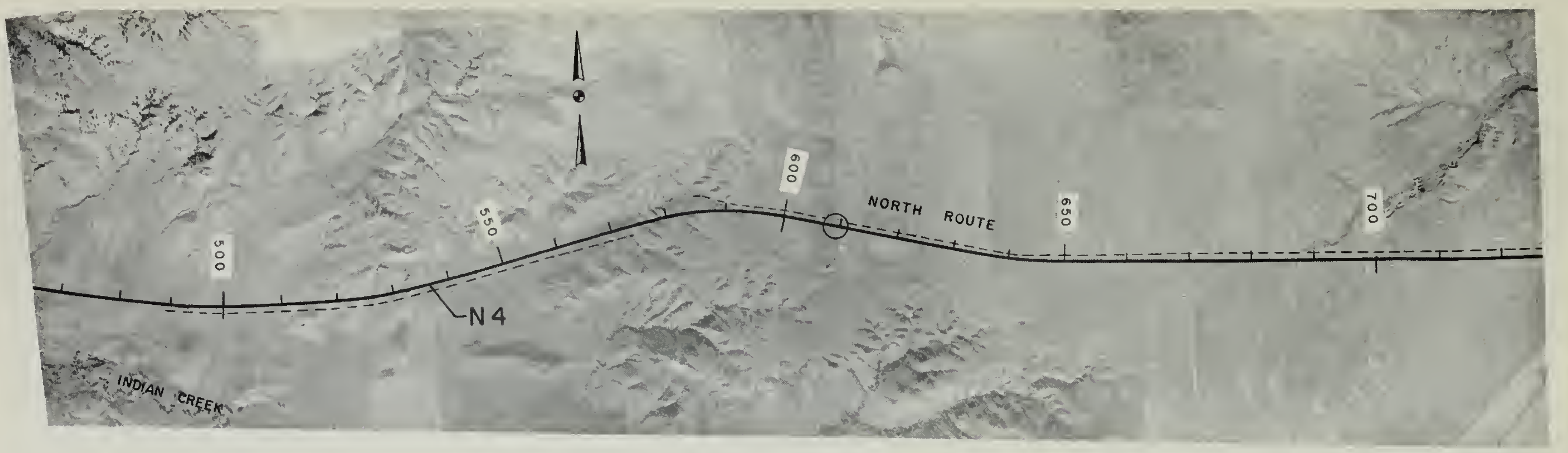


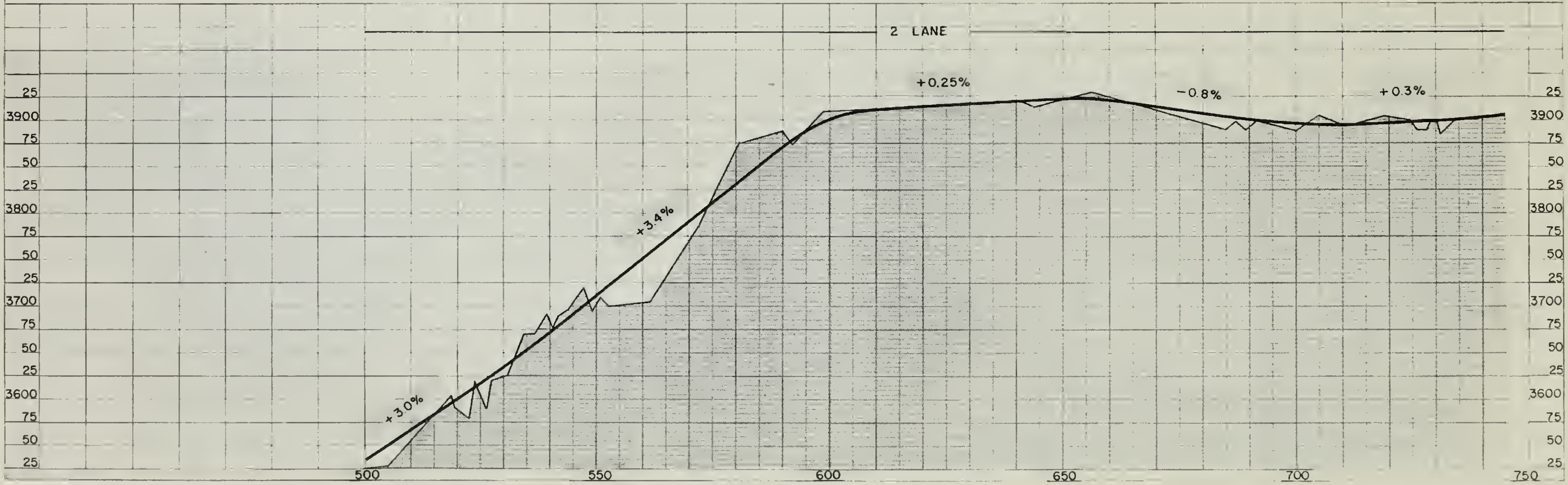

N P R R
0+00
SUBDIVISION
M2 = N2
50
100
150
200
NORTH ROUTE

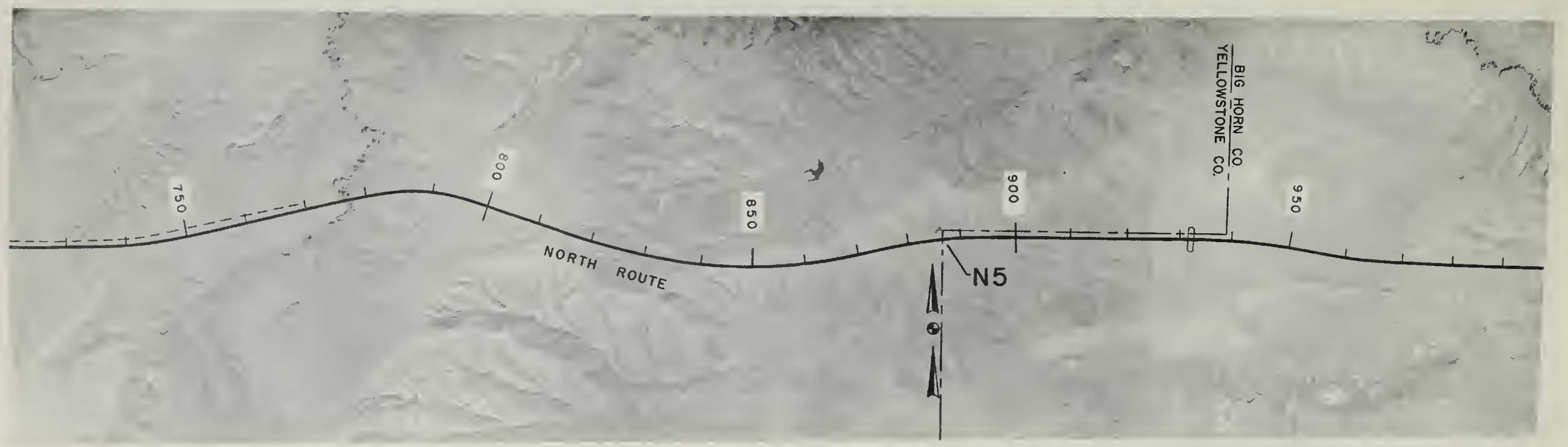

4 LANE
+3.3%
+4.0%
+1.3%
-4.75%
75
50
25
3500
75
50
25
3400
75
50
25
3300
75
50
25
3200
75
50
0+00
50
100
150
200

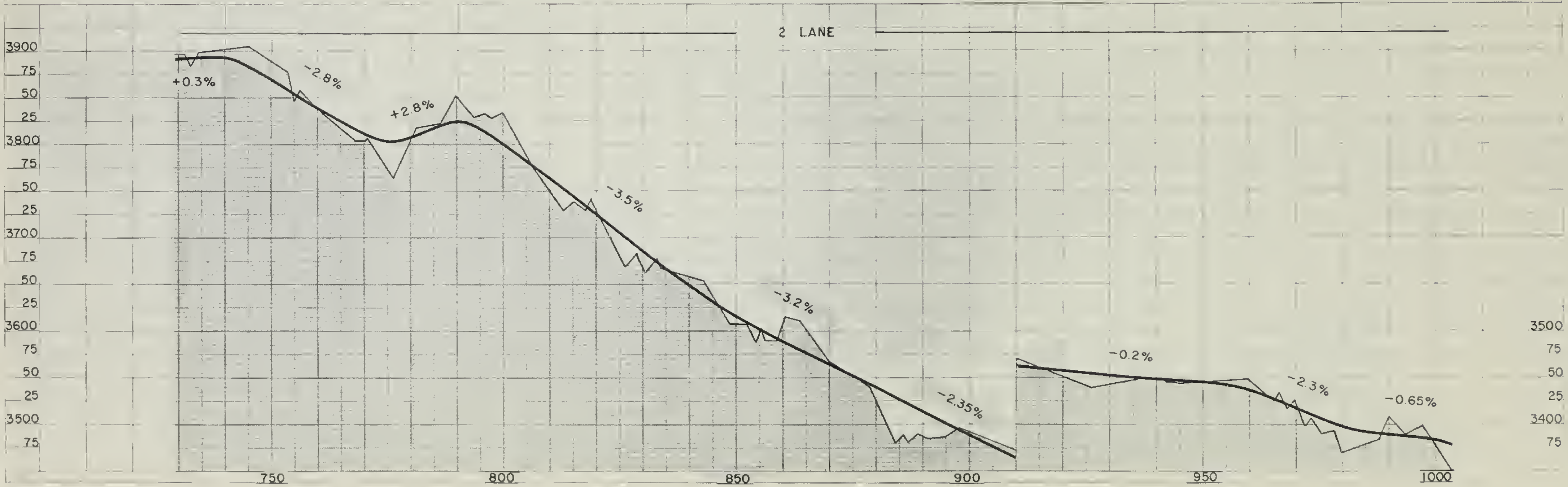

200
250
PRYOR CREEK
N3
NORTH ROUTE
300
350
400
450
INDIAN CREEK
500


4 LANE
2 LANE
-4.75%
-3.35%
+1.2%
+0.5%
+1.1%
+1.4%
+3.7%
+0.25%
+3.0%
50
25
3500
75
50
25
3400
75
50
25
3300
75
50
25
3200
75
50
25
200
250
300
350
400
450
500


INDIAN CREEK
500
550
N4
600
NORTH ROUTE
650
700


2 LANE
+3.0%
+3.4%
+0.25%
-0.8%
+0.3%
25
3900
75
50
25
3800
75
50
25
3700
75
50
25
3600
75
50
25
500
550
600
650
700
750


750
800
850
900
950
NORTH ROUTE
N5
BIG HORN CO.
YELLOWSTONE CO.


2 LANE
+0.3%
-2.8%
+2.8%
-3.5%
-3.2%
-2.35%
-0.2%
-2.3%
-0.65%
3900
75
50
25
3800
75
50
25
3700
75
50
25
3600
75
50
25
3500
75
3500
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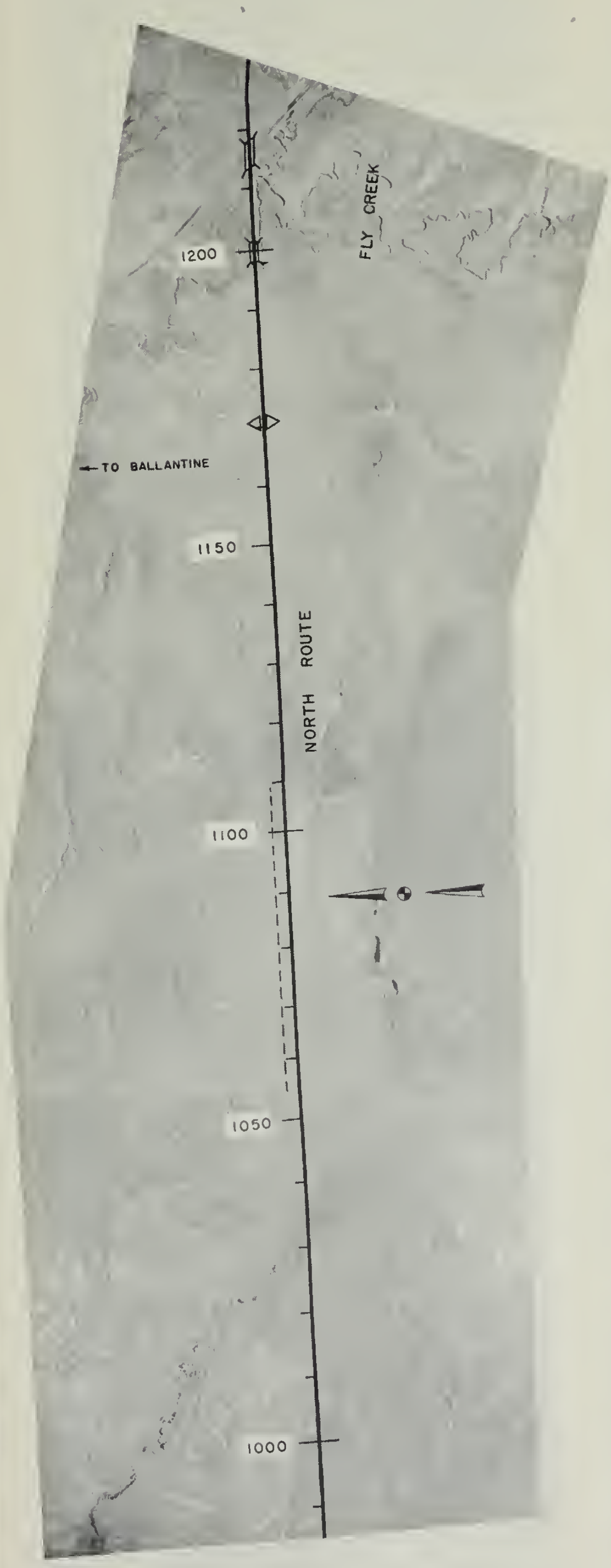
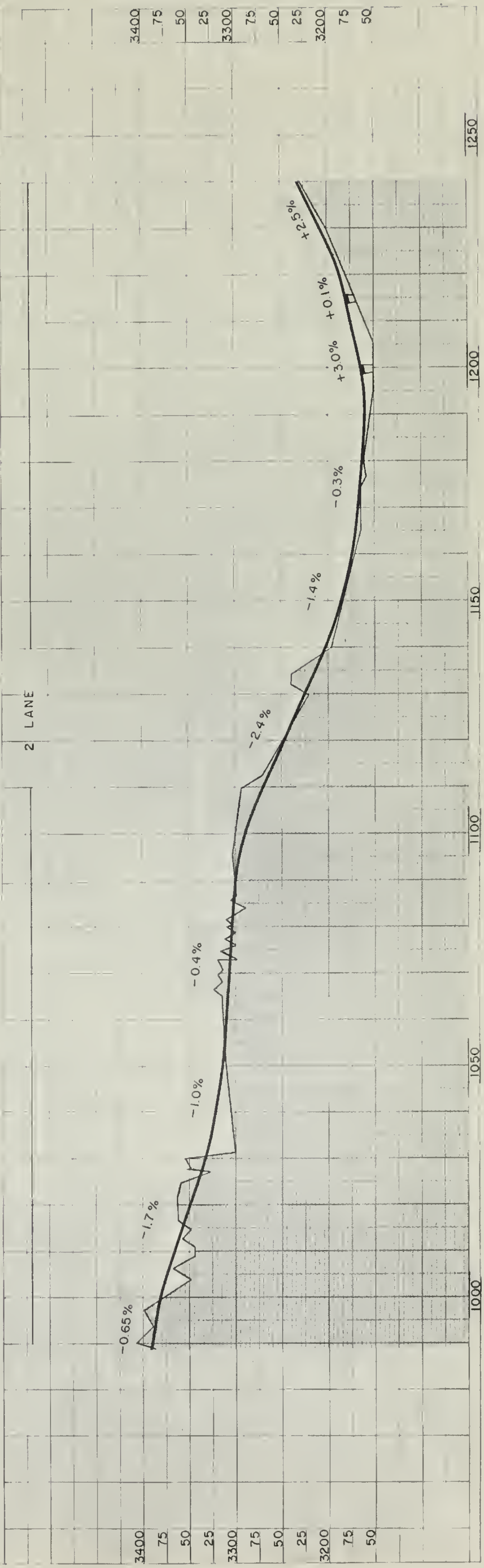
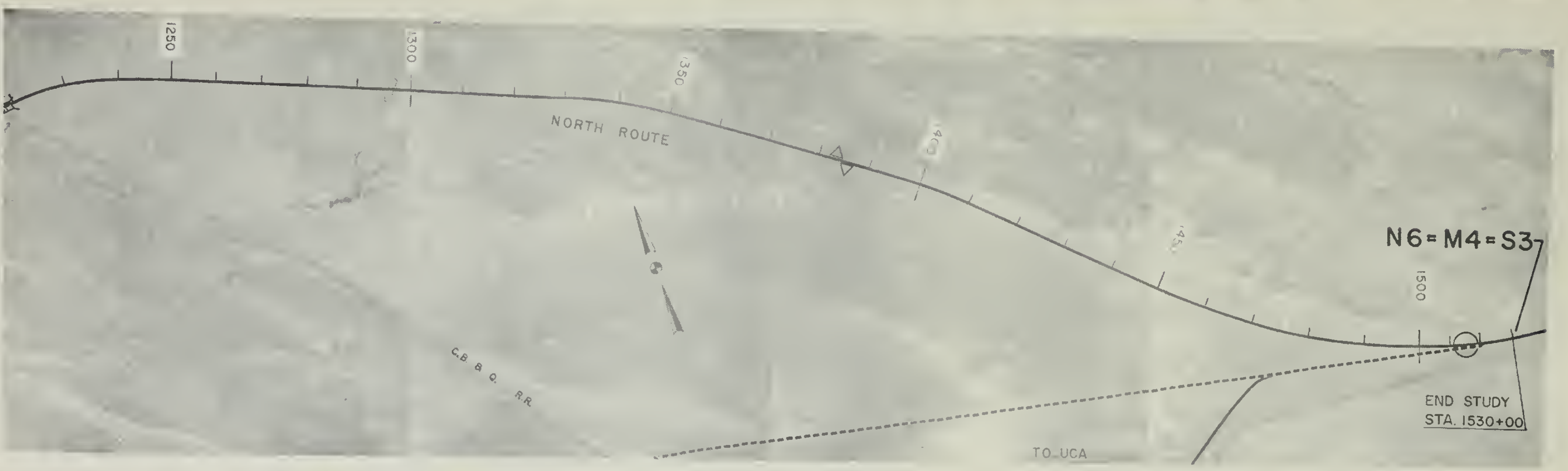
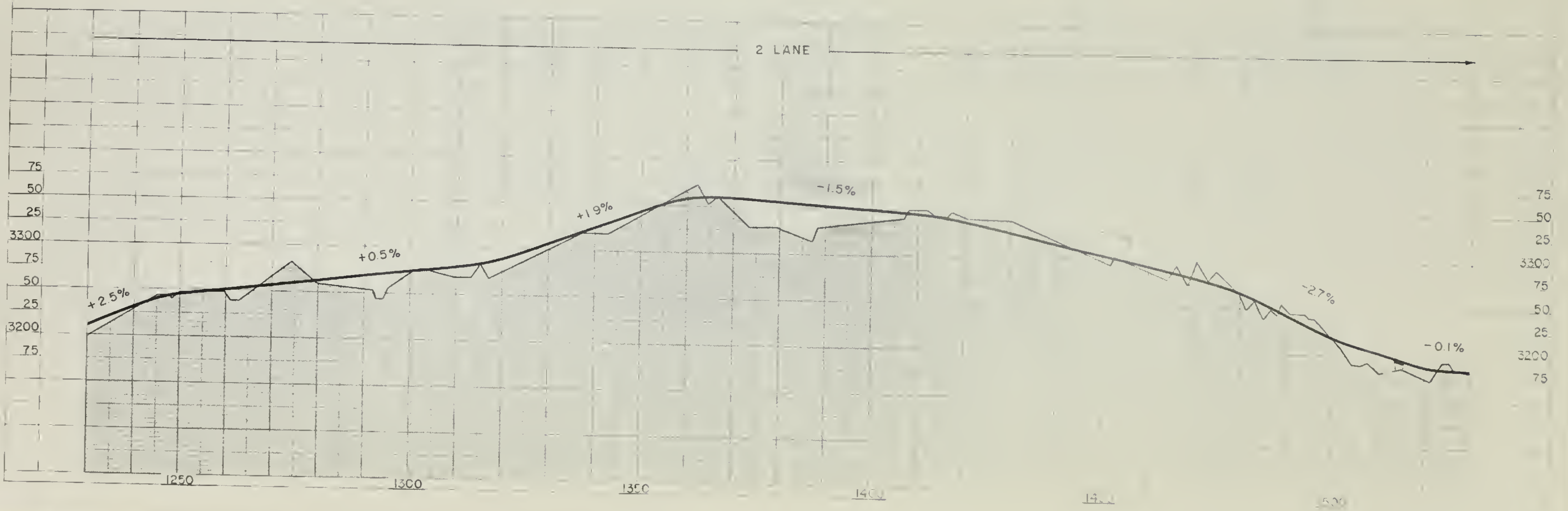
75
750
800
850
900
950
1000


1200
FLY CREEK
← TO BALLANTINE
1150
NORTH ROUTE
1100
1050
1000


3400
75
50
25
3300
75
50
25
3200
75
50
2 LANE
−0.65%
−1.7%
−1.0%
−0.4%
−2.4%
−1.4%
−0.3%
+3.0%
+0.1%
+2.5%
1000
1050
1100
1150
1200
1250

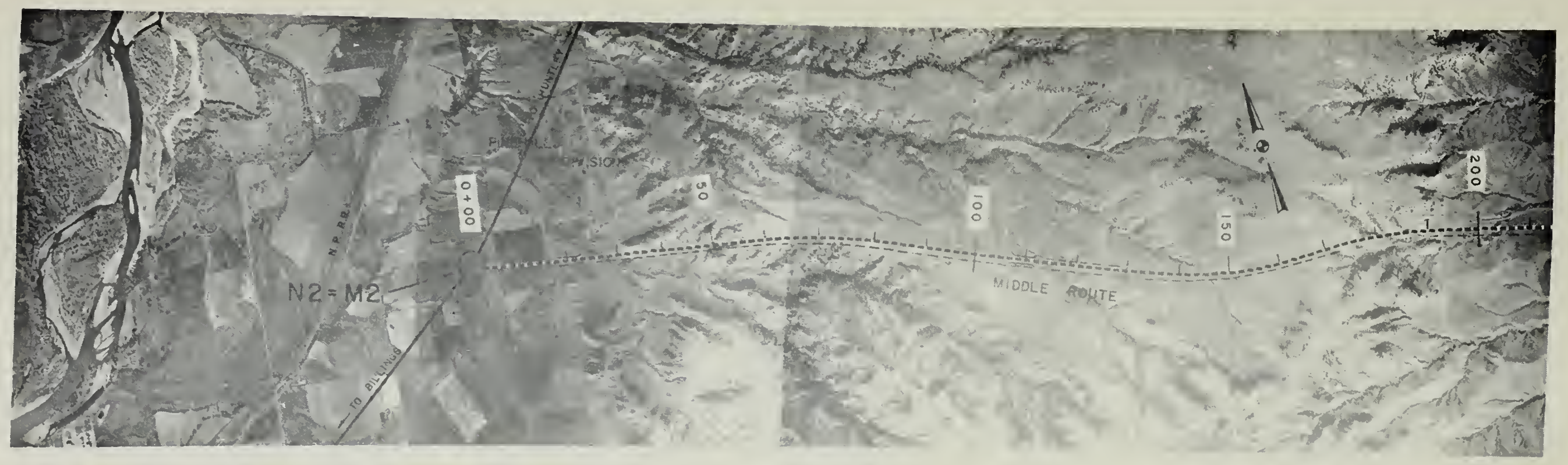

1250
1300
1350
1400
1450
1500
NORTH ROUTE
C.B. & Q. R.R.
TO UCA
N6=M4=S3
END STUDY
STA. 1530+00

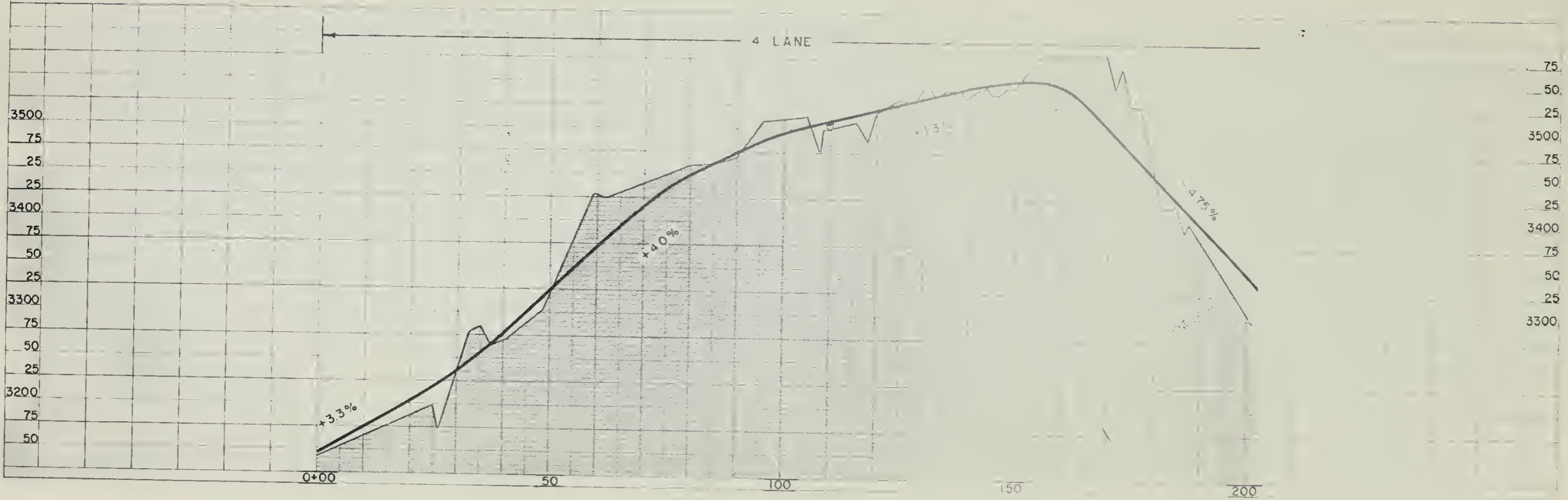

2 LANE
+2.5%
+0.5%
+1.9%
-1.5%
-2.7%
-0.1%
75
50
25
3300
75
50
25
3200
75
1250
1300
1350
1400

MIDDLE ROUTE COST ESTIMATE

SECTION	M1-M2	M2-M3	M3-M4	TOTAL
LENGTH (MILES)		4.9	24.1	29.0
NUMBER OF LANES		4	2	
ITEMS		ESTIMATED COSTS ($1,000)		
GRADE, DRAIN, STOCK PASSES	*	1,557	1,603	3,160
BASE, SURFACING		498	1,283	1,781
RAILROAD SEPARATIONS			89	89
HIGHWAY SEPARATIONS			33	33
INTERCHANGES		504	203	707
BRIDGES		35	79	114
GUARDRAIL, FENCING, SIGNING		83	349	432
CONSTRUCTION COST		2,677	3,639	6,316
RIGHT OF WAY		63	31	94
ENGINEERING, CONTINGENCIES		396	539	935
TOTAL ESTIMATED COST		3,136	4,209	7,345

*Roadway construction is coincidental with I 94 and not included.


TO HUNTLEY
N.P.R.R.
TO BILLINGS
N2 = M2
0+00
50
100
150
200
MIDDLE ROUTE


4 LANE
+3.3%
+4.0%
+1.3%
-4.75%
0+00
50
100
150
200
3500
75
25
25
3400
75
50
25
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3500
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3400
75
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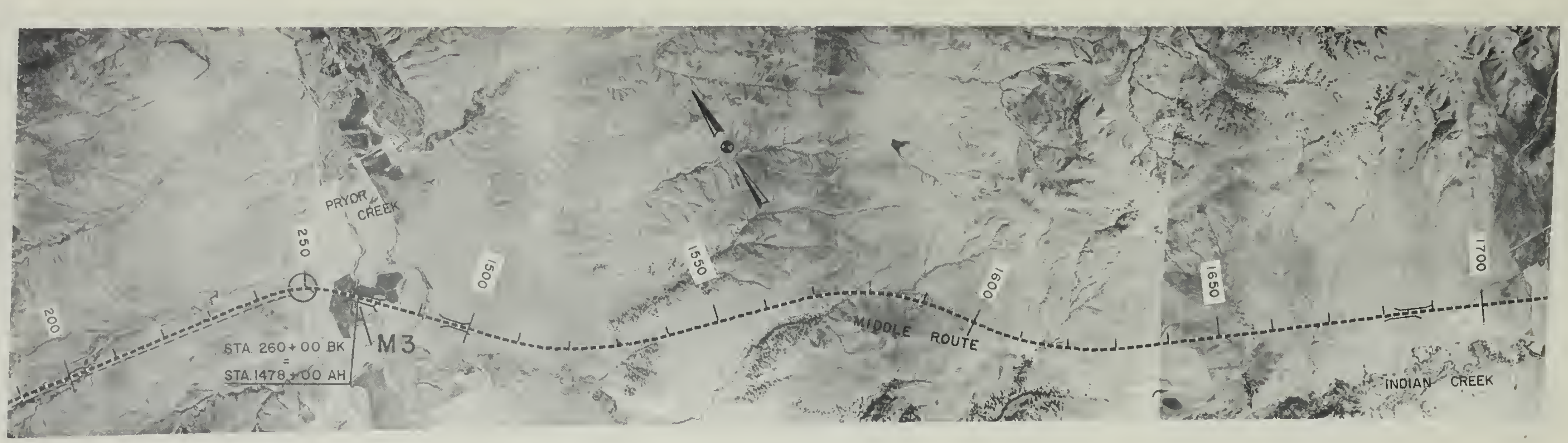
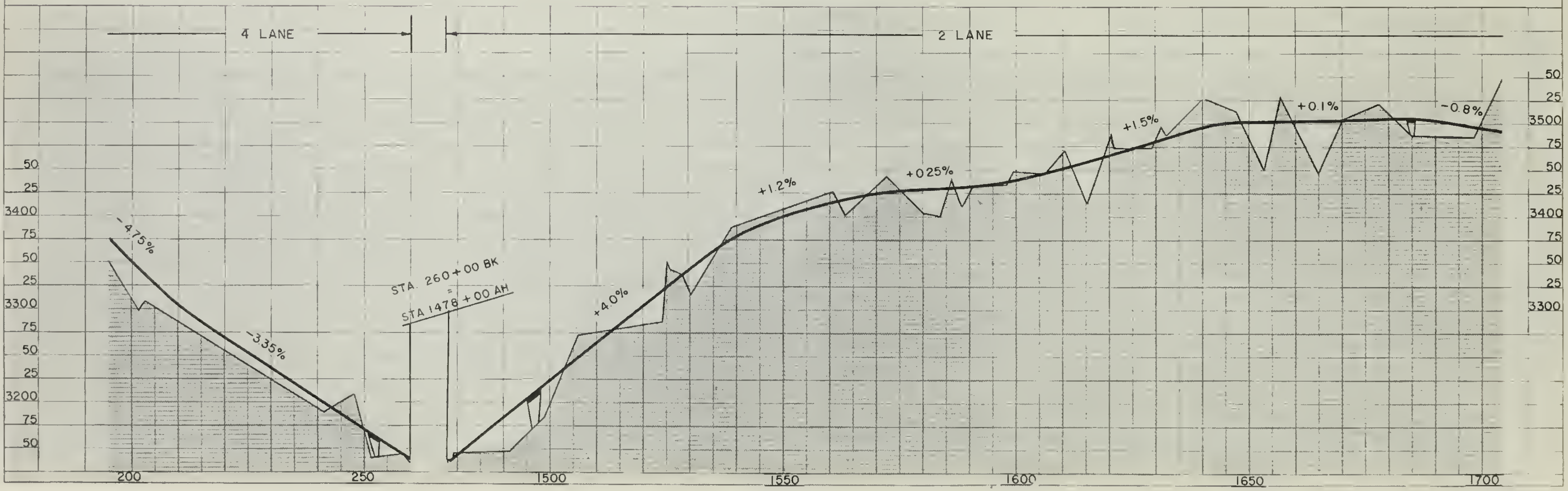
25
3300


200
250
PRYOR CREEK
STA. 260+00 BK
=
STA.1478+00 AH
M3
1500
1550
MIDDLE ROUTE
1600
1650
1700
INDIAN CREEK


4 LANE
2 LANE
-4.75%
-3.35%
STA. 260+00 BK
=
STA 1478+00 AH
+4.0%
+1.2%
+0.25%
+1.5%
+0.1%
-0.8%
50
25
3400
75
50
25
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75
50
25
3200
75
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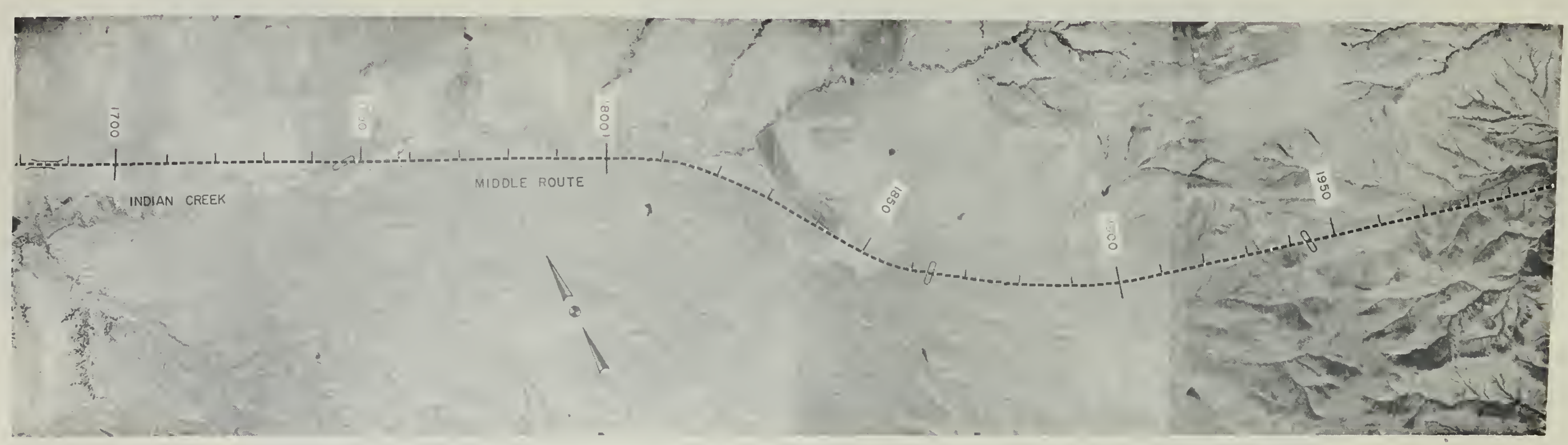
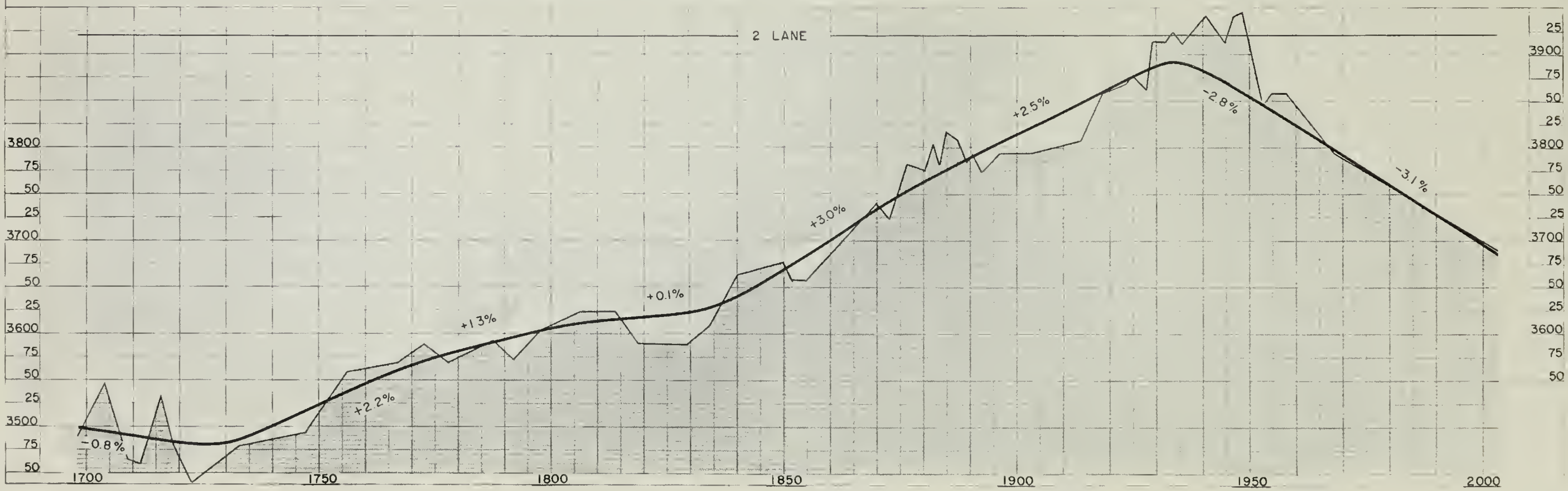
3500
200
250
1500
1550
1600
1650
1700


1700
INDIAN CREEK
1800
MIDDLE ROUTE
1850
1950


2 LANE
-0.8%
+2.2%
+1.3%
+0.1%
+3.0%
+2.5%
-2.8%
-3.1%
1700
1750
1800
1850
1900
1950
2000
3500
75
50
25
3600
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3900
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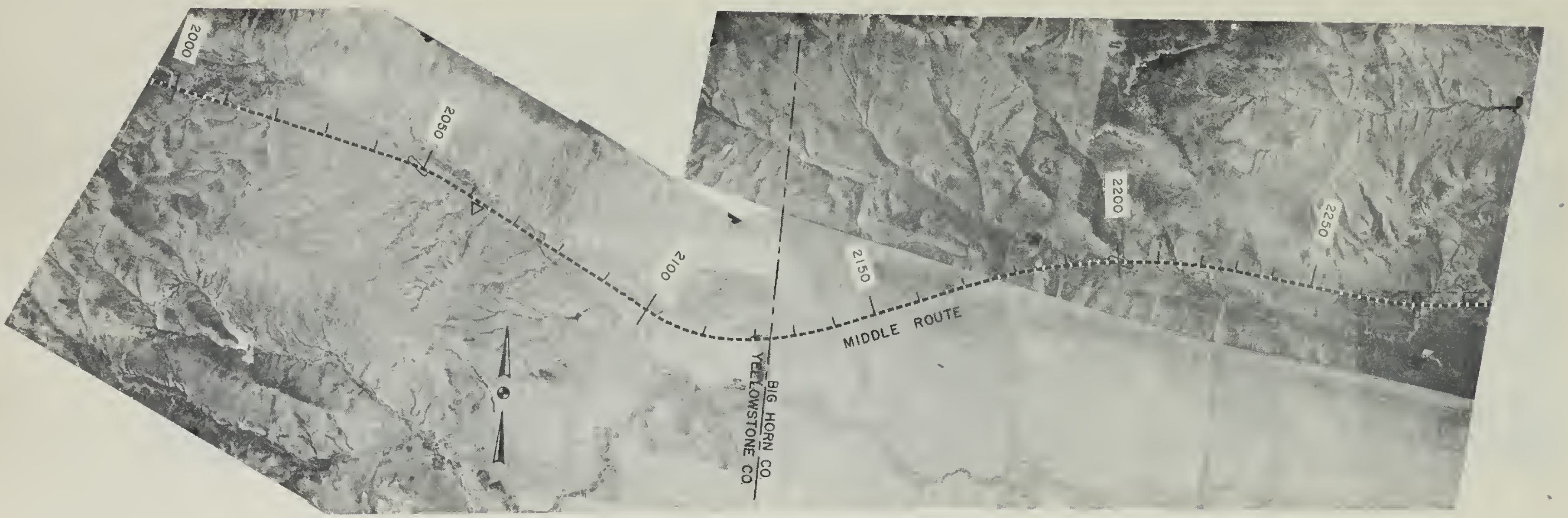
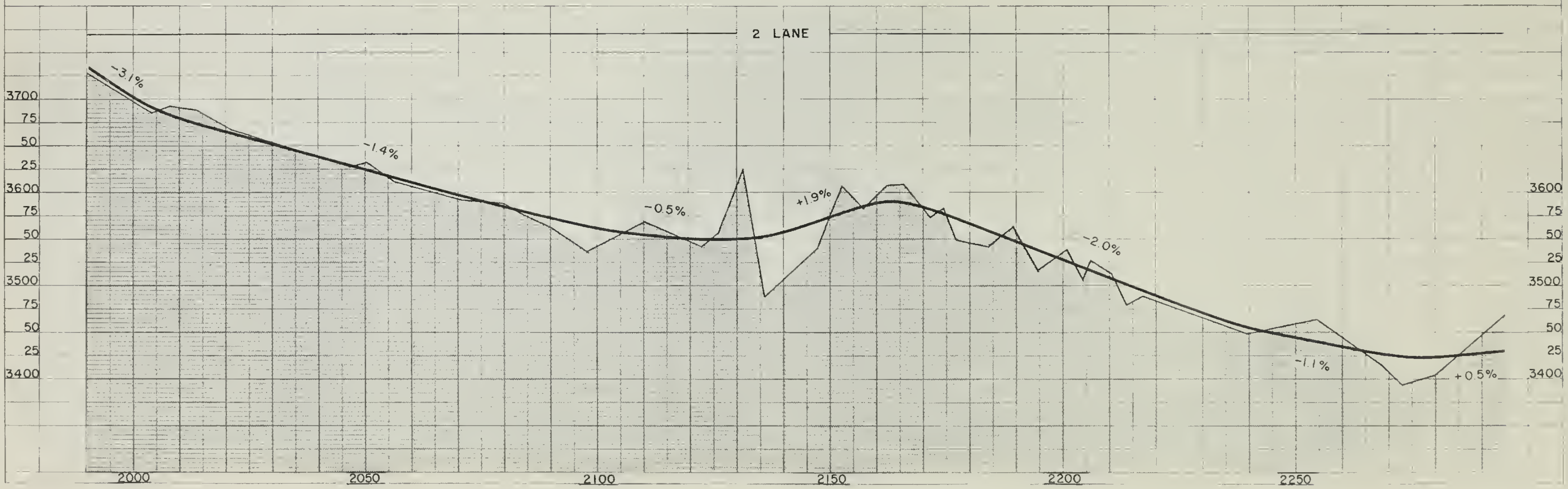
50
25


2000
2050
2100
2150
2200
2250
MIDDLE ROUTE
BIG HORN CO.
YELLOWSTONE CO.


2 LANE
-3.1%
-1.4%
-0.5%
+1.9%
-2.0%
-1.1%
+0.5%
3700
75
50
25
3600
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3500
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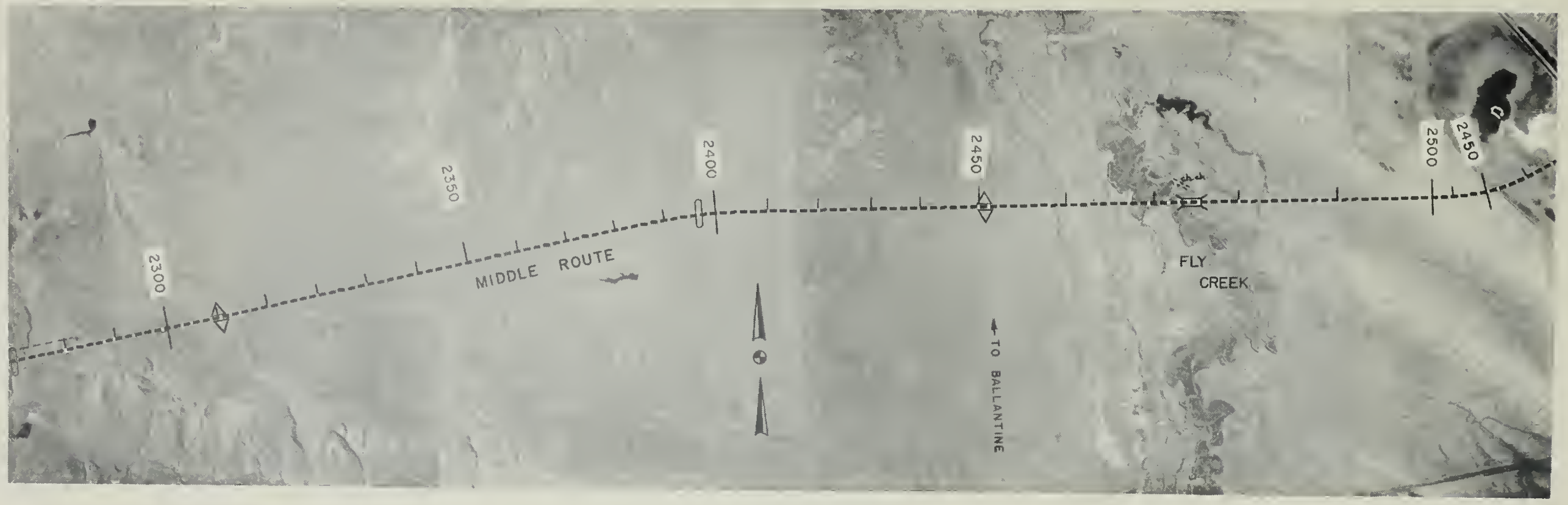
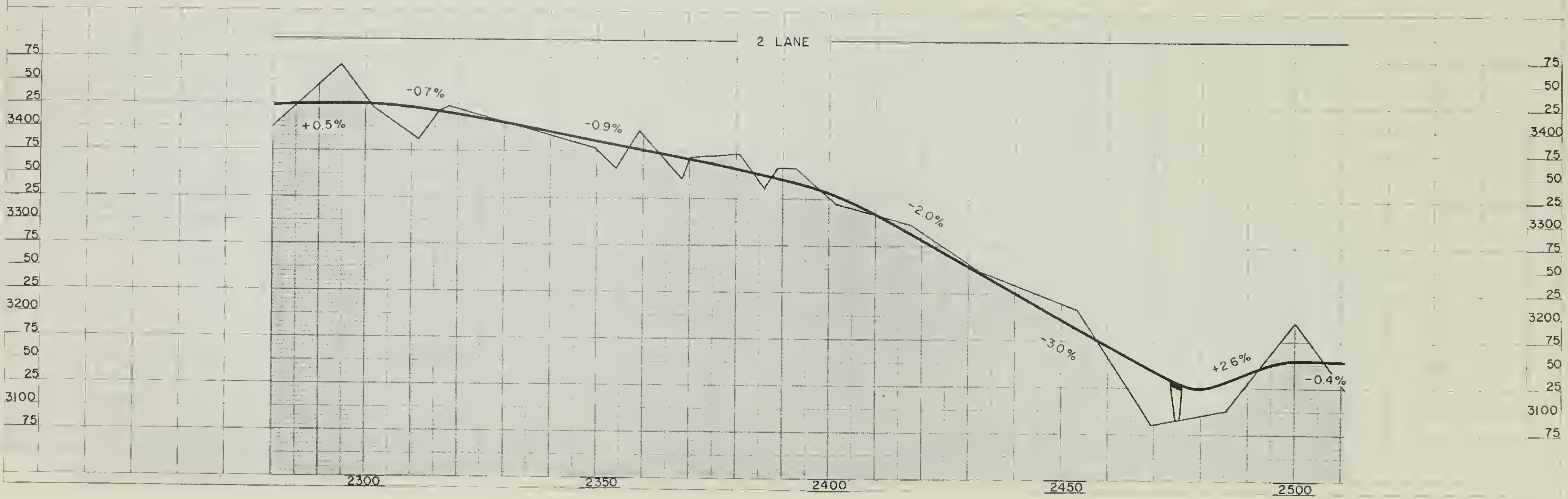
50
25
3400
2000
2050
2100
2150
2200
2250


2300
2350
2400
2450
2500
2450
MIDDLE ROUTE
FLY CREEK
TO BALLANTINE


2 LANE
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-0.9%
-2.0%
-3.0%
+2.6%
-0.4%
75
50
25
3400
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50
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3200
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3100
75
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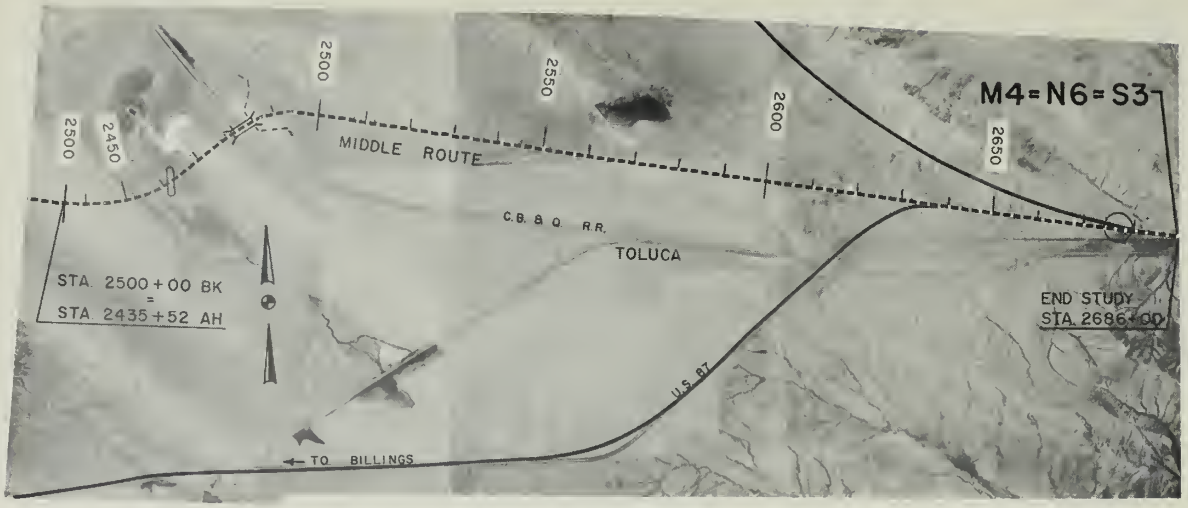
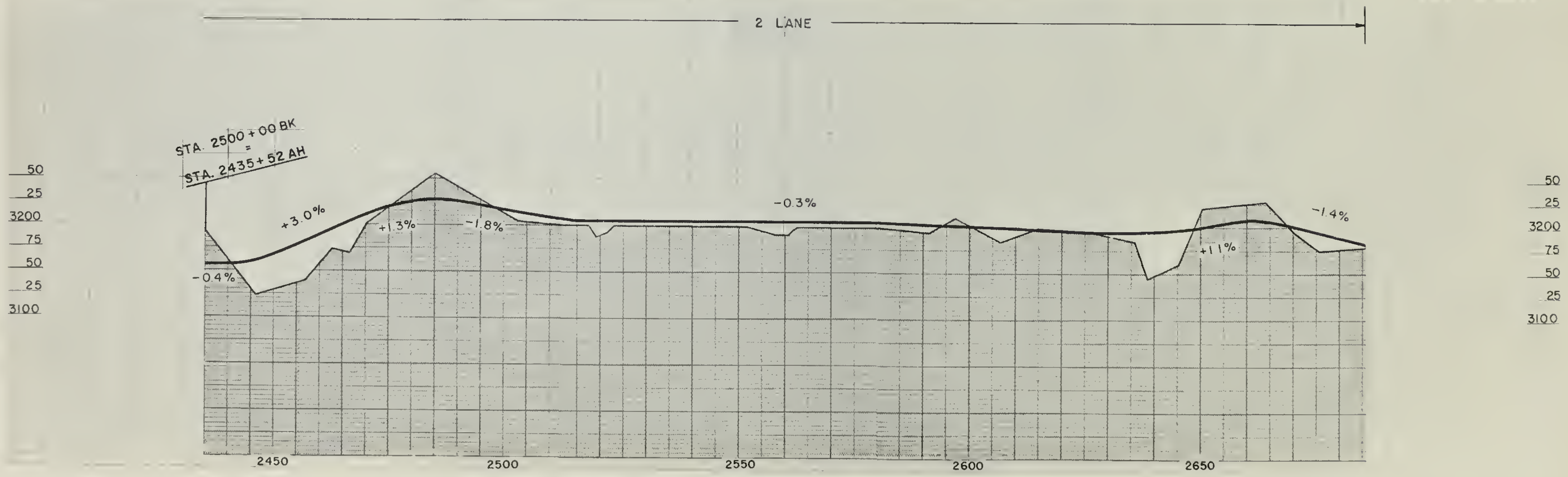
2350
2400
2450
2500


M4=N6=S3
2500
2450
2500
2550
2600
2650
MIDDLE ROUTE
C.B. & Q. R.R.
TOLUCA
STA. 2500+00 BK
=
STA. 2435+52 AH
END STUDY
STA. 2686+00
U.S. 87
← TO BILLINGS


2 LANE
STA. 2500+00 BK
=
STA. 2435+52 AH
-0.4%
+3.0%
+1.3%
-1.8%
-0.3%
+1.1%
-1.4%
50
25
3200
75
50
25
3100
2450
2500
2550
2600
2650

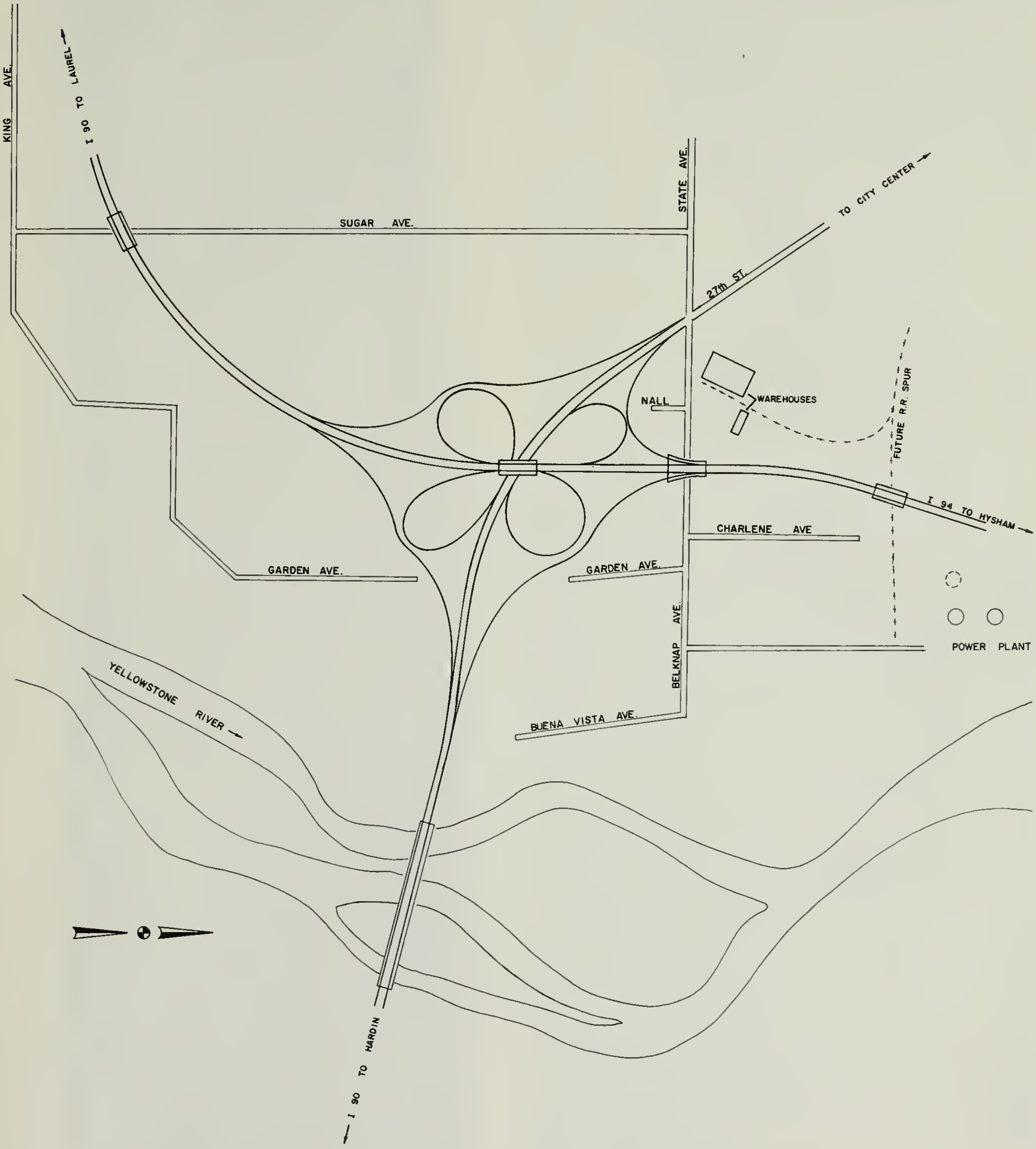
SOUTH ROUTE COST ESTIMATE

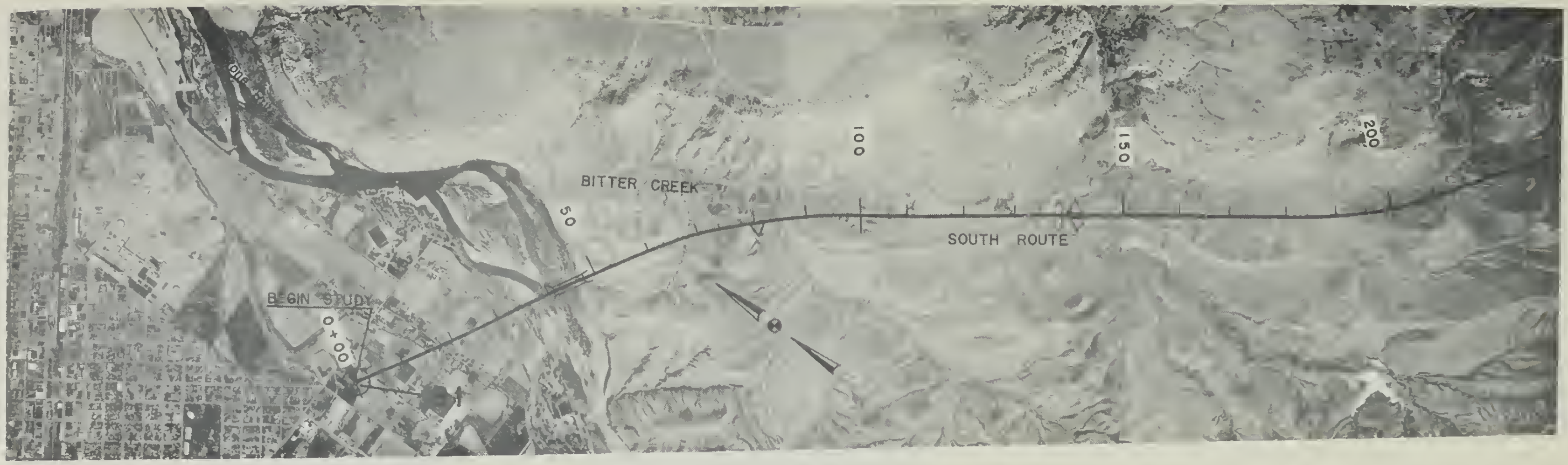
SECTION	27Th ST. INTERCHANGE	S1-S2	S2-S3	TOTAL
LENGTH (MILES)		8.1	26.7	34.8
NUMBER OF LANES		2	2	
ITEMS	ESTIMATED COSTS ($1,000)			
GRADE, DRAIN, STOCK PASSES		1,004	1,686	2,690
BASE, SURFACING		433	1,420	1,853
RAILROAD SEPARATIONS			89	89
HIGHWAY SEPARATIONS				
INTERCHANGES	439*		205	644
BRIDGES		892	79	971
GUARDRAIL, FENCING, SIGNING		110	239	349
CONSTRUCTION COST	439	2,439	3,718	6,596
RIGHT OF WAY	176	4	24	204
ENGINEERING, CONTINGENCIES	147	276	550	973
TOTAL ESTIMATED COST	762	2,719	4,292	7,773

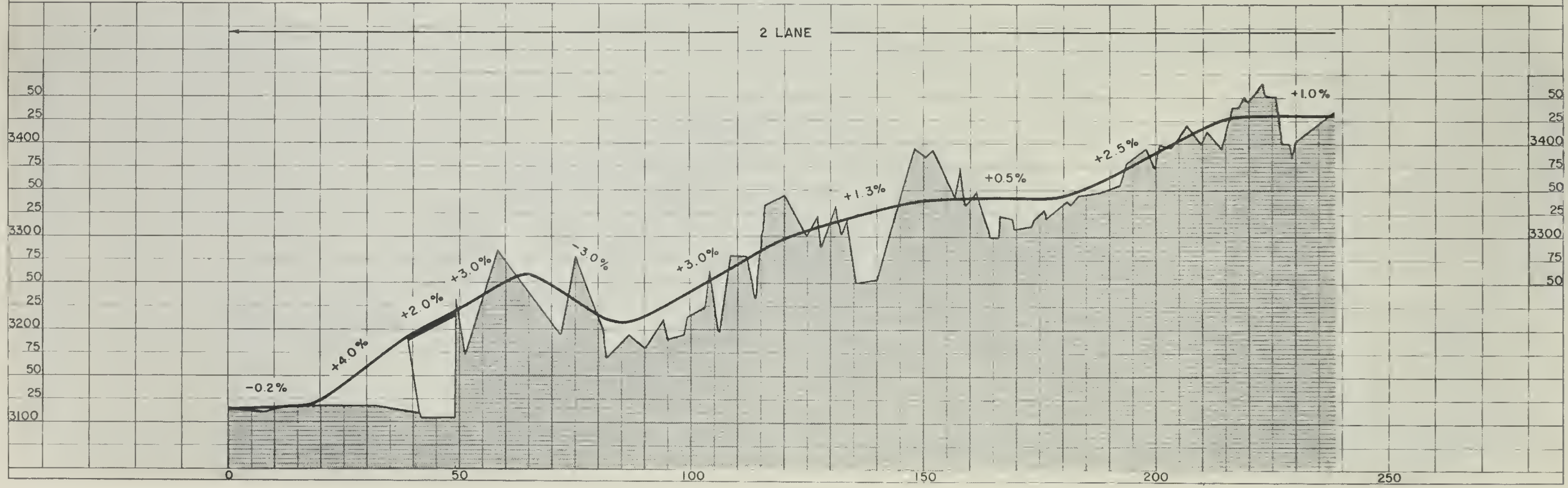
*Cost differential for a more complex interchange than is required for the North and the Middle Routes.

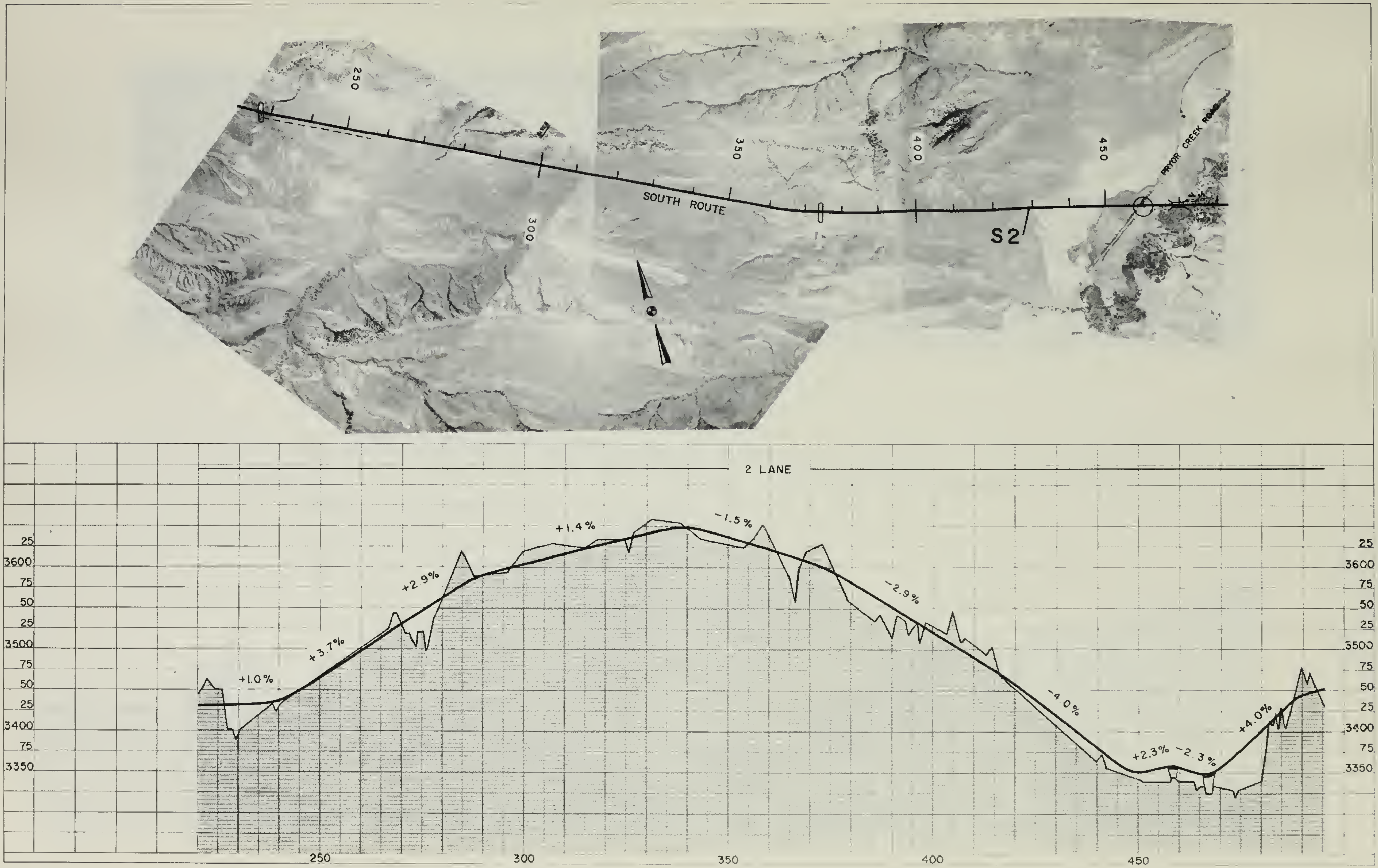
27TH ST. INTERCHANGE

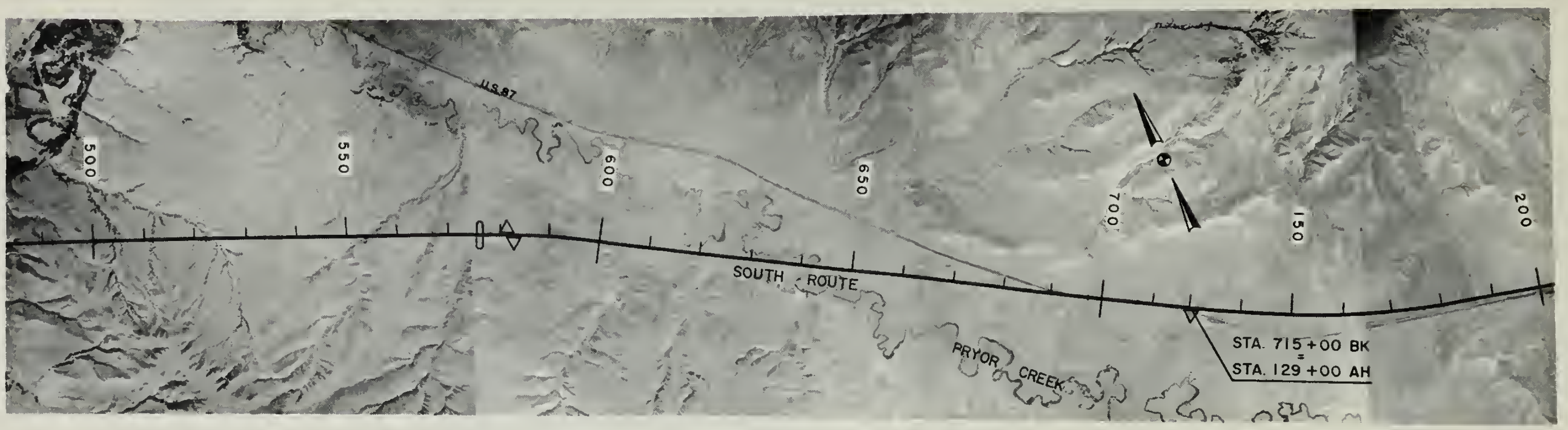
SOUTH ROUTE



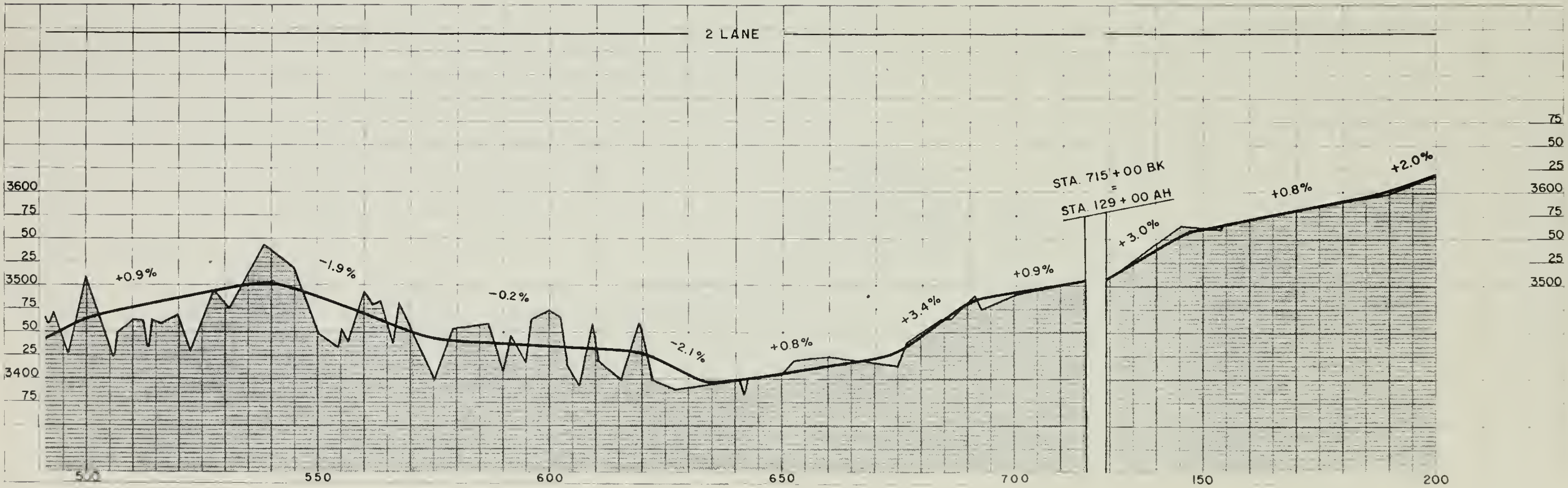

BEGIN STUDY
0+00
50
BITTER CREEK
100
150
200
SOUTH ROUTE


2 LANE
-0.2%
+4.0%
+2.0%
+3.0%
-3.0%
+3.0%
+1.3%
+0.5%
+2.5%
+1.0%
3100
25
50
75
3200
25
50
75
3300
25
50
75
3400
25
50
0
50
100
150
200
250

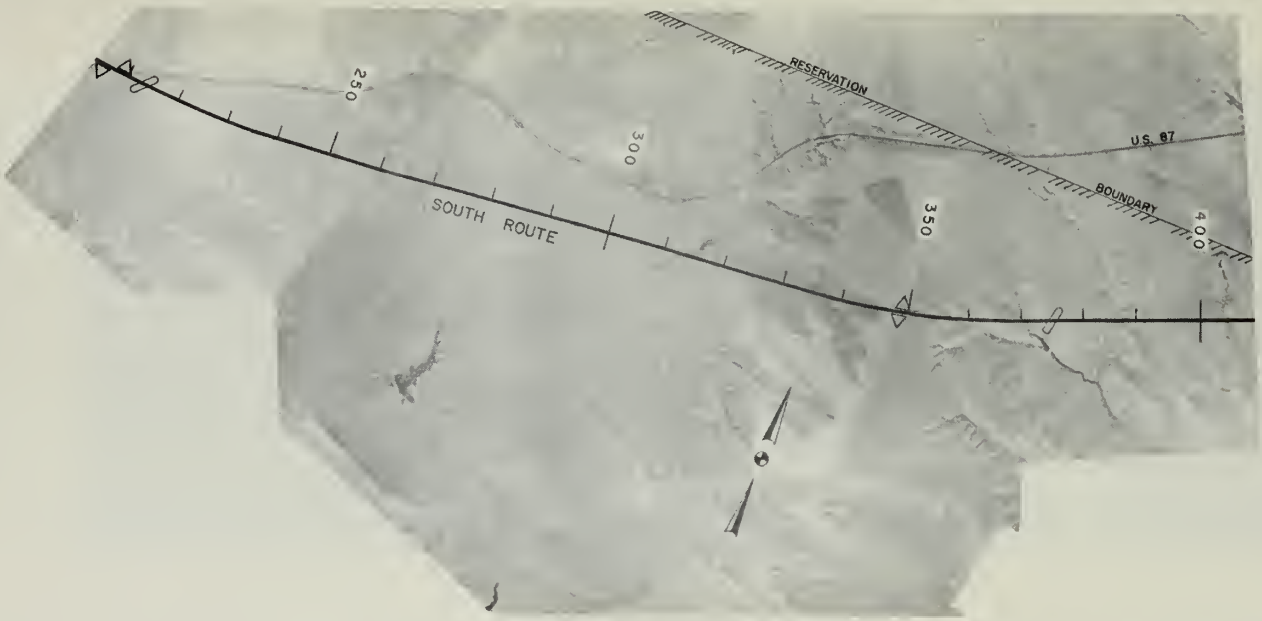

250
300
350
400
450
SOUTH ROUTE
S2
PRYOR CREEK ROAD
2 LANE
+1.0%
+3.7%
+2.9%
+1.4%
-1.5%
-2.9%
-4.0%
+2.3%
-2.3%
+4.0%
25
3600
75
50
25
3500
75
50
25
3400
75
3350
250
300
350
400
450



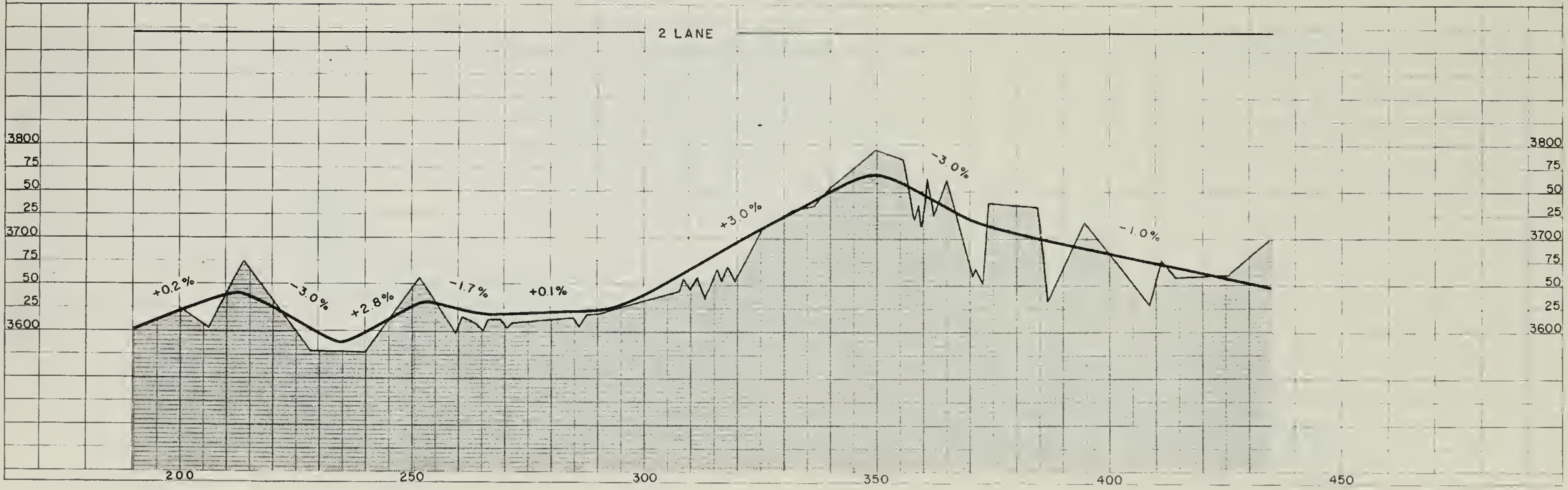
500
550
600
650
700
150
200
U.S. 87
SOUTH ROUTE
PRYOR CREEK
STA. 715 + 00 BK
=
STA. 129 + 00 AH



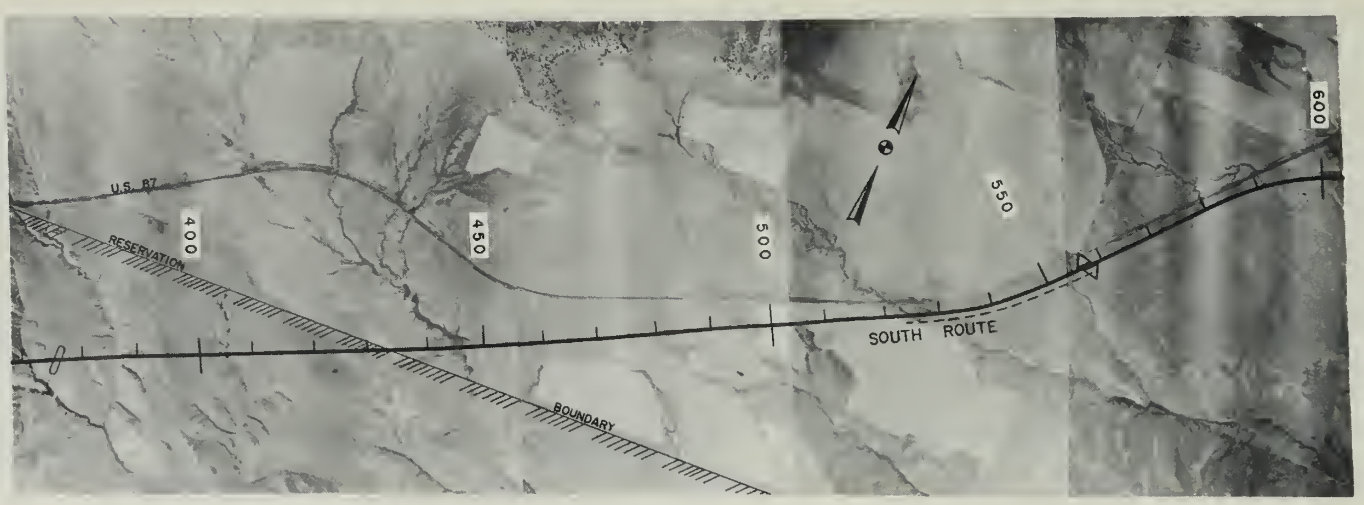
2 LANE
STA. 715 + 00 BK
=
STA. 129 + 00 AH
+0.9%
-1.9%
-0.2%
-2.1%
+0.8%
+3.4%
+0.9%
+3.0%
+0.8%
+2.0%
3600
75
50
25
3500
75
50
25
3400
75
500
550
600
650
700
150
200



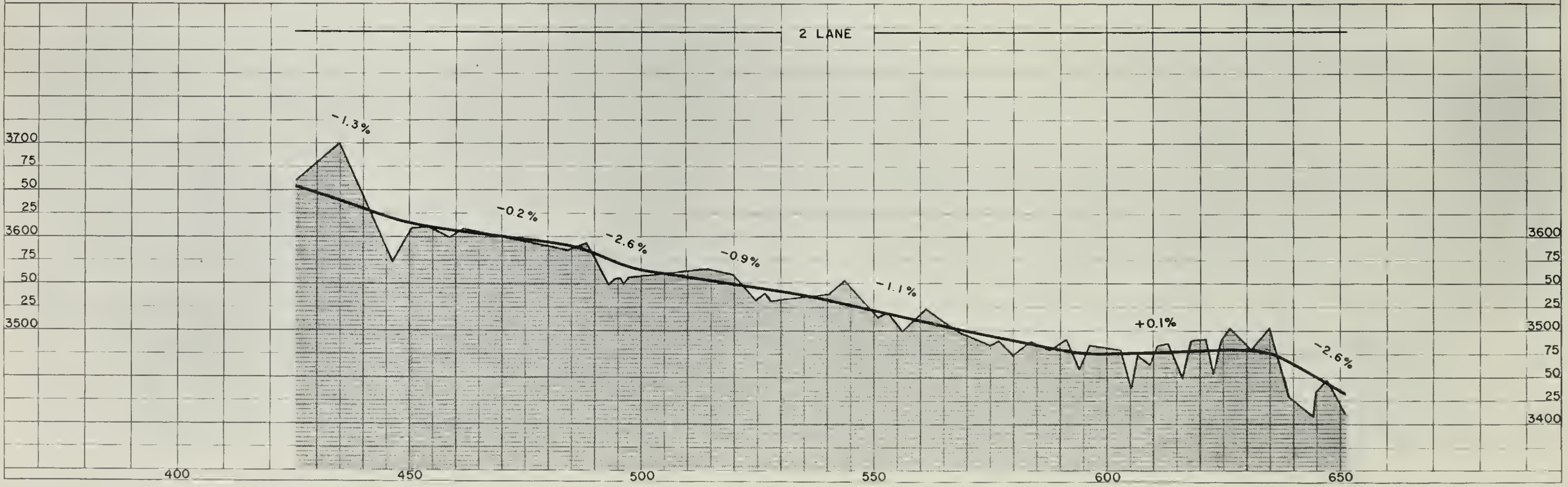
RESERVATION
BOUNDARY
U.S. 87
250
300
350
400
SOUTH ROUTE



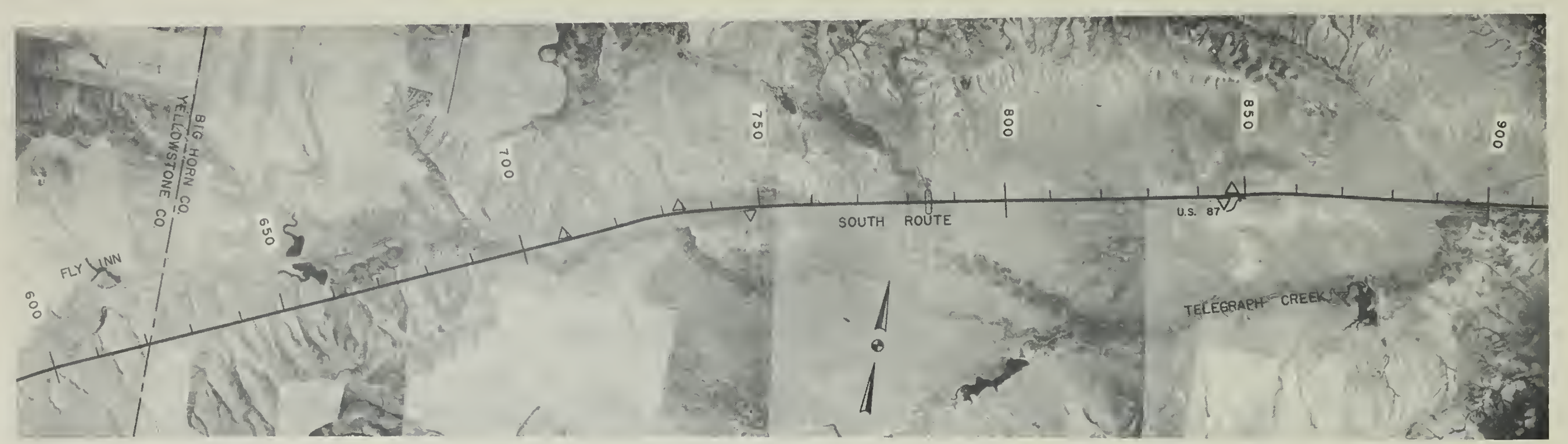
2 LANE
+0.2%
-3.0%
+2.8%
-1.7%
+0.1%
+3.0%
-3.0%
-1.0%
3800
75
50
25
3700
75
50
25
3600
200
250
300
350
400
450

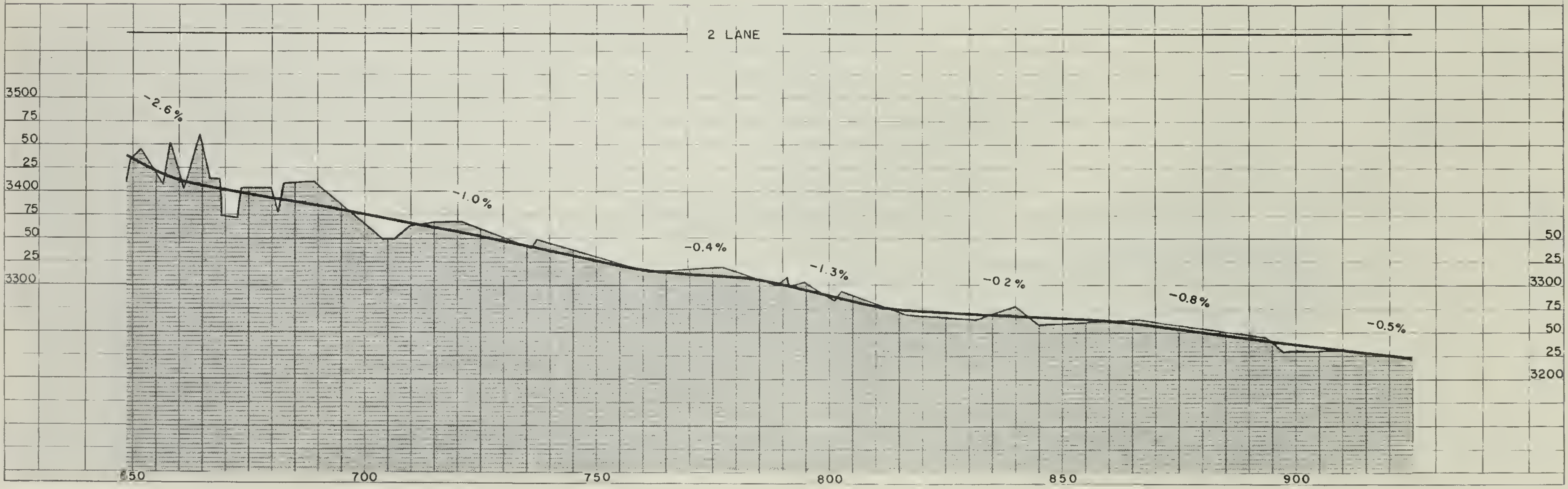


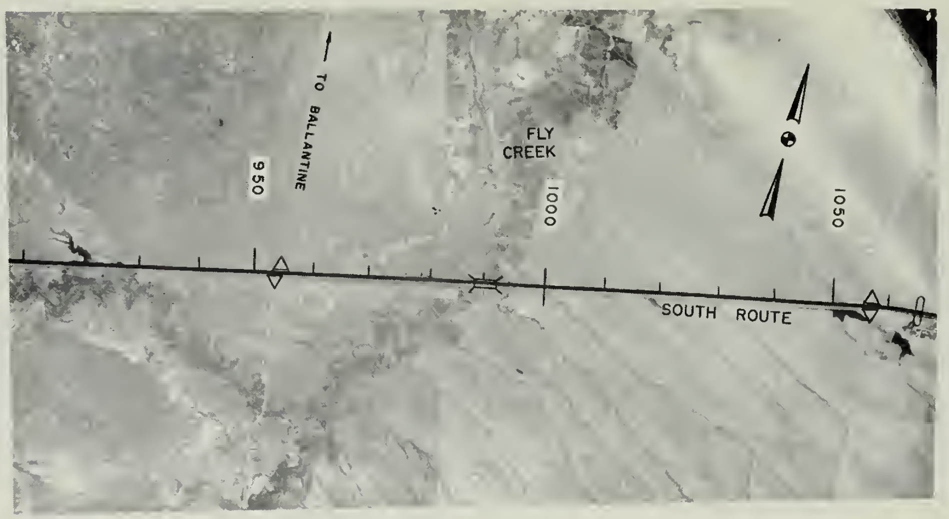
U.S. 87
400
RESERVATION
450
500
550
600
SOUTH ROUTE
BOUNDARY

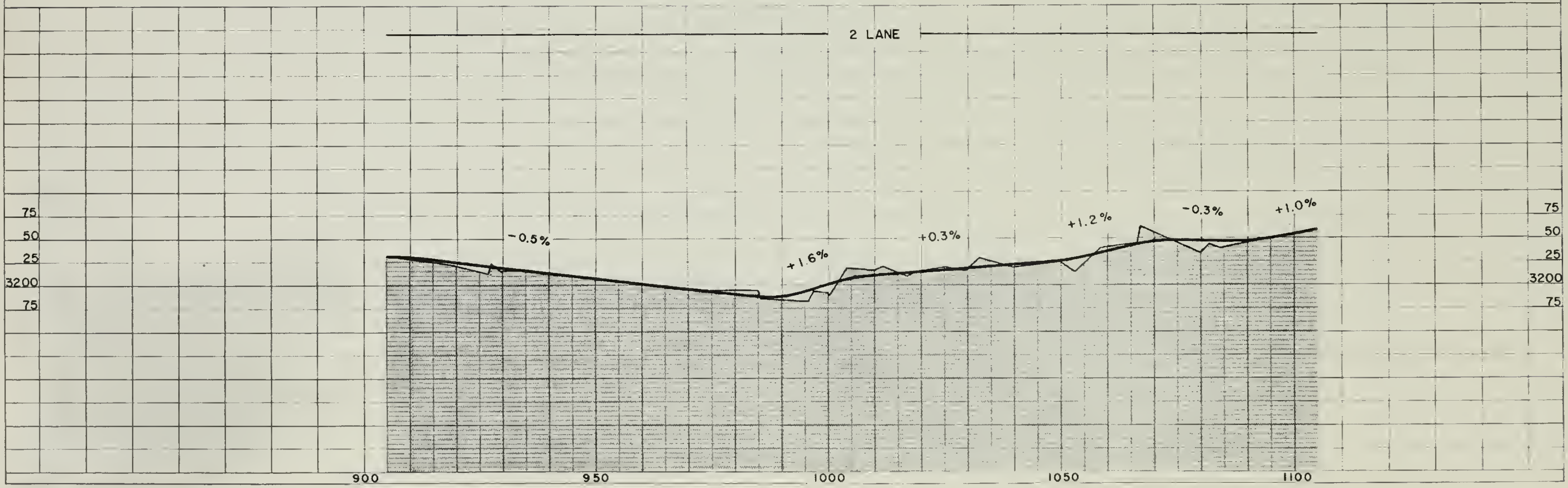


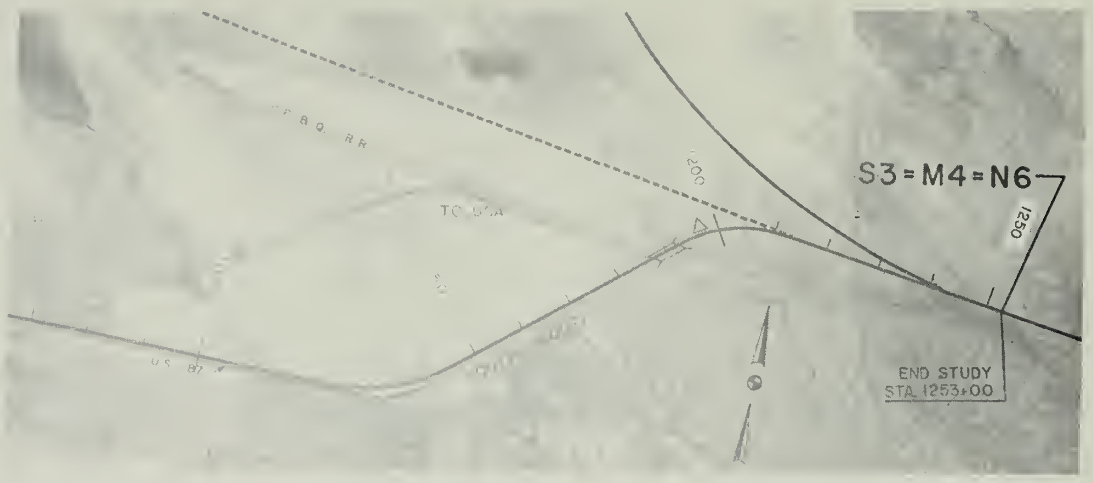
2 LANE
-1.3%
-0.2%
-2.6%
-0.9%
-1.1%
+0.1%
-2.6%
3700
75
50
25
3600
75
50
25
3500
3600
75
50
25
3500
75
50
25
3400
400
450
500
550
600
650

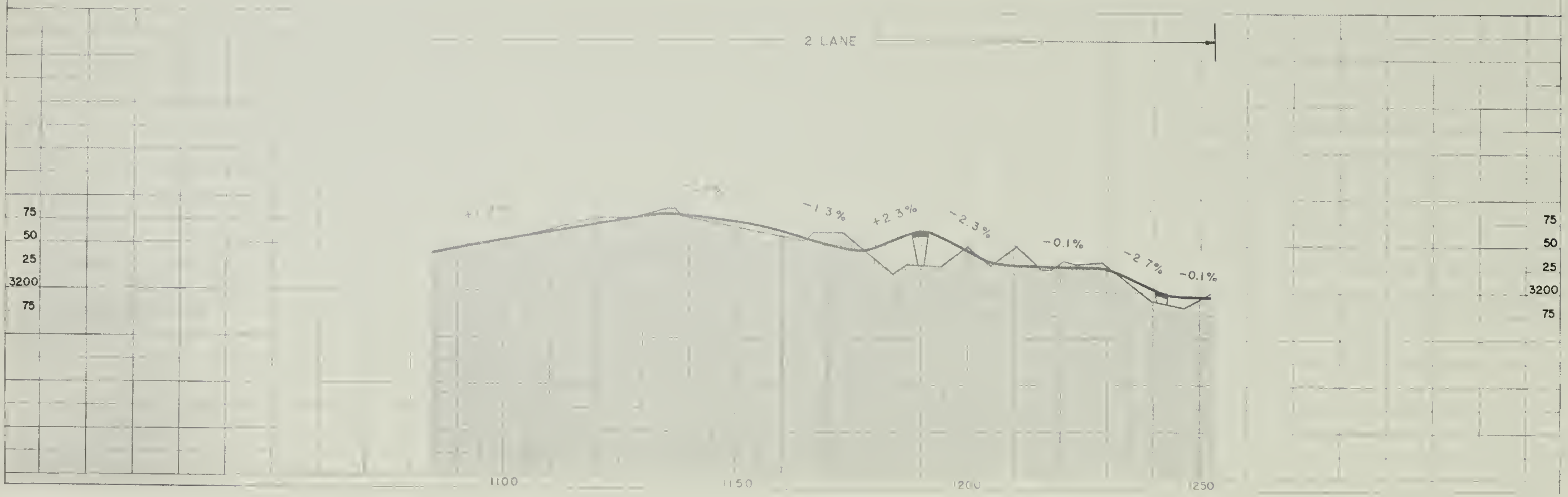

600
FLY INN
650
BIG HORN CO.
YELLOWSTONE CO.
700
750
800
SOUTH ROUTE
850
U.S. 87
900
TELEGRAPH CREEK


2 LANE
3500
75
50
25
3400
75
50
25
3300
-2.6%
-1.0%
-0.4%
-1.3%
-0.2%
-0.8%
-0.5%
50
25
3300
75
50
25
3200
650
700
750
800
850
900


TO BALLANTINE
950
FLY CREEK
1000
1050
SOUTH ROUTE


2 LANE
-0.5%
+1.6%
+0.3%
+1.2%
-0.3%
+1.0%
75
50
25
3200
75
900
950
1000
1050
1100


S3 = M4 = N6
1250
1200
END STUDY
STA 1253+00
US 87


2 LANE
-1.3%
+2.3%
-2.3%
-0.1%
-2.7%
-0.1%
75
50
25
3200
75
1100
1150
1200
1250